

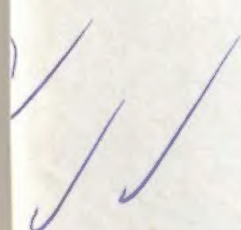
EDUCATION IN DIGITAL AGE



R.K. RAMANNA

All that postmodernity seems to offer education is a recognition of difference, through agonistic challenge and ludic parology. They see postmodernity loosening up education, creating spaces for 'resistance and students' experience; giving local "voice" to the different and shifting knowledges through which the social formation is constituted.'

The concept of 'critical modernity', can lead to individual and collective acts to bring about change. The institutional dimensions of modernity, the global abstract systems that seem like an uncontrolled juggernaut, can be guided by human agency. The site of struggle, in each case, may be seen in terms of human communication. Late modernity, far from being a time of fragmentation of human experience, produces a situation in which humankind in some respects becomes a "we", facing problems and opportunities where there are no "others". A post-traditional order opens the possibility of "a cosmopolitan conversation of humankind", and identifies only four ways in which value disputes can be resolved: embedding of tradition, which in modernity is undermined; disengagement, the possibilities of which are limited; discourse, or violence.



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Preface

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It may be the case that a more balanced human understanding is necessary, not least in education theory,

policy and practice, that includes as theoretical, symbolic and expressive understanding; or to as cognitive instrumental, moral-practical and aesthetic-expressive domains of human reason. Such a balance is not achieved by a swing from the hubristic idea that everything can be known, to the weakness of individual language games and parology.

Editor

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Education Since 1947

As with so many programmes initiated by the government, the driving force all these decades has been the middle class. Most people recognise that it was the middle class which inherited power in 1947. Whatever might have been the details or the mechanics, political power has during these five decades been exercised by this class: Consequently, things which interested the middle class got done and those that did not interest it did not get done. This is as much applicable to education as to so many other sectors of activity. The middle class was interested in professional education. So more and more engineering and medical colleges came to be established. If there were not enough jobs for them, the easiest thing was to migrate abroad. For 30-40 years, India has been exporting trained manpower to other countries, chiefly to the US. The higher the degree of competence required, the more easily they were exportable; IIT graduates, for instance. The Indian population in US which was only a few thousands in 1947, has now gone beyond one million. Most of them are professionals.

They got their training in India and went there for education and very often decided to settle down there. The migration policies of that country helped in no small degree. Of late things have become difficult. Therefore, Indians have started moving to Australia and several

South East Asian countries. UK was a destination right from the beginning. But the bulk of them are not professionally trained. In Canada, about one third are professionals whereas the rest are doing other jobs. The Gulf area has long been a favourite haunt.

The truth of the matter is that after 1947 while India had an opportunity to build a strong economy, modernise her agriculture and increase her national income, the opportunity was more or less frittered away. For about four decades, India followed the Russian model of a command economy and state ownership of the means of production.

In India, the means of production were not taken over by the state except, as they put it, the commanding heights of the economy were sought to be controlled by it. A fairly extensive public sector was thus established.

At the end of forty years, it was discovered that India was almost as poor as she used to be. However, the population had multiplied almost three times. It is during the last decade or so that the rate of economic growth has significantly got ahead of the rate of growth of population somewhat. In this process, education has been knocked out of shape so much so that the numbers today are forbiddingly large and it is going to be difficult to make a clear break with the dead weight of tradition. In other words, for the next few decades, India will continue to be a stagnant economy and, to boot, a semi-educated nation.

In 1931, in a public address, Gandhi who was attending the Second Round Table Conference in London, said two things which both rattled his listeners. One was that India was more literate before the British came than she was now. This created enormous controversy. Secondly he said that, at this rate of spreading literacy, it might take a hundred years, almost

for everybody to be educated. While the rate of spread of literacy has been stepped up somewhat during the last five decades, India has been able to educate only half the adults. (In that respect Gandhi's prediction has been proved true). Since the rate of growth of population does, not show any significant decline, it is now going to be a race between the growth, of population and the ability of the country to spread universal literacy.

The third factor is no less crippling. While private enterprise does exist at the elementary level, essentially it is the government which is carrying the main load. Before 1947, schools were controlled by District Boards. If teachers were transferred, they were transferred within the district. Now in about two thirds of the states, they can be transferred gill over and, as everybody knows, transferring teachers is virtually an industry in which politicians, bureaucrats and corrupt elements play almost equal roles. This demoralises teachers and comes in the way of their competent performance. In all fairness, it must also be added here that a substantial number of teachers have got accustomed to a low rate of performance. They oppose, in particular, any form of local control. This would oblige them to perform. Vested interests have grown and, on the whole, it is a dismal and confused picture.

Owing to large scale expansion of numbers (approximately 160 million students), there has been considerable growth in the number of secondary schools too. Their level of performance, however, is poor. No one looks upon school education as a terminal stage of education. Whoever can manage it likes to join college. Even in a backward state like UP, 51 per cent join college. The figures in respect of Kerala and Maharashtra are 69 and 79 per cent respectively. The trend to join college after the senior secondary level is unmistakable. College education is cheap as well as undemanding. Therefore, a

large number of students choose to join college. This, inevitably, brings down the standards of college education as well. As a matter of fact, an organised system of under performance has grown up.

At every level of education, what is required to be done is not done and there is a good deal of unfinished business. This is generally taken care of at the next stage. For example, not many primary school students retain their skill in literacy five years later. It is only when, they spend another three years at the upper primary level that they become fully literate though there is no reason why five years of schooling should be inadequate, for acquiring basic literacy. These students are deficient, in knowledge and skills when they go to the secondary school. When they pass out, they cannot hold their own against school graduates in other countries. They seek to compensate this deficiency by going to college. No wonder, an average college in India is half school and half college.

This deficiency in performance is, to quite an extent, the outcome of bad planning and worse implementation. At one level, poor implementation refers to the planning stage. At another level, this refers to the poor performance of those who are engaged in teaching. Both those who frame educational policies and those who implement them, i.e., the teachers, do not perform as well as they are expected to. So far, it is these issues that have been dealt with. It is time, however, to turn to the wider context in which education takes place.

The wider context refers to the social and economic policies which the country has been following over the last few decades. Something was said about it earlier. What requires to be said further is that the low rate of literacy is largely decided by the widespread poverty and the inability of most people to have access to schools. In

plain terms, a large number of people either have no access to education or, when they manage to get access, they do not have the staying power to carry on. Dropping out becomes unavoidable, therefore. In this connection, two points need to be noted. The first one is that it is mainly the Hindi speaking states which are performing badly.

A couple of other states, Orissa, for example, also comes under this description but for the most part, the neglect of elementary education is more or less confined to UP, Bihar, MP, and Rajasthan. Of all the southern states, only the Telengana area in Andhra is lagging behind. It is by no means a coincidence that these are exactly the states which are under developed and over populated. One does not have to quote data in support of this statement because, this is widely, accepted. States on the rimlands, right from Kerala to Himachal Pradesh are doing well, comparatively speaking. Still the ideal of having hundred per cent literacy is very, very distant. Mean while, the population is booming and, as noted by so many people, almost half the world's illiterates are and will continue to be found in India. To say no more About it, with out a radical remodelling of the strategy of growth, it is idle to believe that India will be able to overcome the problem of illiteracy.

If this statement is analysed further in concrete terms, it will be seen that it is mainly certain sections of the population which are lagging behind. They are women and those belonging to the scheduled castes and the scheduled tribes. The Muslims as a whole have a much lower rate of literacy than the rest. Indeed this is one mark of their backwardness. In order to be able to solve this problem, therefore, social changes of a fairly comprehensive kind Would have to be carried out. Without some kind of radical social restructuring, things are not likely to improve. In brief, problems that our

country have to solve are of two types—social as also economic. Both have to be simultaneously tackled in order to be able to get results.

When it comes to teachers at different levels, the most urgent thing to ensure is that the profession of teaching is given a much higher social status than it enjoys at present. To some extent, this has something to do with the low wages which are given to teachers. But to some extent it also depends upon 'the teachers' performance and the role that they play in the social set up. Their only intervention by them so far has been to ask for higher wages and better conditions of work. This is in order. If they do not ask for improvements in their conditions of service, Who else will. But should it stop at that?

To put it no more strongly, policy making is left to bureaucrats. Even ministers play, a peripheral role. Most of them are not competent enough to understand the issues. By default, therefore job is done by bureaucrats. The right thing to do, however, would be for the teachers, at different levels, to play a constructive and pioneering role. Most of them, sad to say, however, lack the ability to do so. Yet another proof of the fact that a large number of them, perhaps more than 50 per cent, are in teaching not because they wanted to be teachers but because nothing else was available.

No profession in India is bigger in number than the profession of teaching. But it would be a somewhat extravagant to claim that teaching is a profession everywhere. In terms of what they do more than five million are teachers. In terms of what sociologists would describe the sociology of the profession, the vast majority do not measure up to the expectations and requirements of the job.

They are hardly self governing as competent professionals are expected to be. Nor do most of them have that sense of professional pride which comes from being well paid and well respected. The fact of the matter is that a very large number of teachers go into teaching not because this is what they prefer, but because—and this is no exaggeration—they are unable to get other jobs.

At the lower levels most, teachers lack the capability to decide for themselves. The gap is filled up by bureaucracy. They control things to a substantial extent and issue orders which teachers are expected to carry out. Till 1947, as already stated, District Boards used to control primary education within the district. In the mid 50's when prices began to rise, the District Boards found it difficult to pay according to the higher rates of remuneration.

District Boards were, therefore, more or less obliged to relax their control over primary education. This was taken over by the State governments, and as they say, elementary education as provincialised.

This led to a new evil which had not been encountered till then. Teachers came to be transferred all over the State, This led to discontent, manipulation and corruption as already referred to. Though the rigours of the system were modified to some extent, in state after state, a transfer industry grew up. In about two thirds of the states today, teachers are transferred for all kinds of reasons, sometimes they want the, transfers but more often it is the politicians and bureaucrats who wield power and do it with generally devastating effects. Perhaps nothing during recent decades has more sullied the image of the, teachers than the fact that they Are transferred in season and out of season and quite often, against their wishes.

Worse than everything else, they cease to be individuals who have some dignity of their own. Instead they become commodities which can be moved from one place to other. Some interesting experiments have been carried out in certain states. In Rajasthan, for example, teachers have been recruited from the local community. They do not always come up to the requirements laid down but with a little training these locally recruited teachers begin to perform well.

Yet another interesting experiment was carried out by M.P. recently M.P. has a substantial tribal population. They are also amongst the least literate. The state, therefore, devised a policy that if the local community took the initiative to set of a school, within a few months, the State government would be obliged to provide teachers as well as a building. This imaginative policy seems to have given considerable impetus to public initiative and led to positive results.

Various experiments made in various states will have to be looked at and things improvised so as to suit the needs of each state. For instance, the total Literacy Campaign which started in Kerala some years ago led to favourable results in several parts of the country but is now beginning to lose its momentum. In that situation something else will have to be devised. All these different observations point to one point. Things have to be constantly improvised and at no point of time should there be a feeling of stagnation.

One last thing about professional education. There are more than a dozen bodies established by the Centre dealing with the maintenance of standards in respect of their respective specialisations. These bodies deal with medicine, engineering, architecture, legal education and so on. Each one of them has, to some extent, played a helpful role. But the problem is that there is too much of

political interference in their working. There is not a single political party about which it can be said that it believes in high standards of performance, and objectivity in official functioning. Each one is motivated by those petty considerations which can only be frowned upon and even condemned. That is to say that these important policy makers get involved in issues, like postings, promotions, appointments and things like that. It must be understood clearly that, as the country grows, the growth of professionalism has also to grow. Without strengthening the standards or professional performance, thing will never improve.

To some extent, the same applies to the UGC. Of the various professional bodies, it is the oldest and perhaps the most influential. For the last two decades it has been under, intense pressure of teacher power. That is how it became a party to the, notion of automatic promotion. This single aberration played havoc with the maintenance of standards. It cannot be said that the UGC has fully cured, itself of this indefensible mode of thinking. It is necessary that it should do so, otherwise the UGC will continue to be a factor In favour of low standards rather than high standards.

Modern Concepts of Education

Since the late 1960s we have seen several writers propose different ways of conceptualizing the manner in which systematic educational evaluation should take place. When these proposals are added to several somewhat earlier conceptions of educational evaluation, we find that today's educator has a fairly varied menu of evaluation models from which to choose. In this chapter the more prominent of these educational evaluation models will be examined. There are some who would disparage the efforts of those theorists who attempt to build models such as those describing educational evaluation. Such critics contend that the models resulting from the efforts of theorists are just that, *theories*, and are too impractical to be of value to the educational practitioner who is faced with a host of daily decisions.

The evaluation models proposed in recent years are anything but impractical in their orientation. The people who devised these models sensed a deficiency in the way educators typically approach their evaluation tasks.

The model-builders wanted to conceptualize evaluation procedures approximately in order to get evaluators to proceed properly. Instructional approaches had been around for decades. Curriculum ideas were clearly old hat. Evaluation notions were, for many educators, brand new playthings. The evaluation theorists of the late sixties and early seventies wanted to

guide educators so that they would carry on their evaluation endeavours in a more enlightened fashion. And let no one doubt that these evaluation models have been influential.

Many of the educational evaluations of the past few years have been modeled almost religiously after one of the evaluation schemes proposed by such people as Michael Scriven, Robert Stake, and Daniel Stufflebeam. When people don't really know how to go about a task, they often turn wherever they can for counsel. Their gravitation toward some of these theoretical evaluation models was only natural. Although it is true that most of the recently proposed models of educational evaluation were designed to guide the actions of educational evaluators, some are more successful than others in that regard. Several of the models are convoluted enough to make a schizoid maze-builder applaud. Others are so jargonistic that they almost defy comprehension, at least without a short course in vocabulary distortion. But even with their defects, the currently available models offer a number of different choices for the educational evaluator. The more conversance one has with these educational evaluation models, the more likely one is to discern alternative courses of action. And because, in general, people make better decisions if they understand their options, educational evaluators should attempt to become familiar with the major models now at hand.

Although it is sensible for educational evaluators to inform themselves of the nature of educational evaluation models, they should not get too caught up in that enticing but enervating game known as *comparative model meshing*. Some people take great delight in seeing how Model X differs from Model Q and is ever so slightly like the seventy-ninth stage of Model Z. This kind of model comparison may present avocation for the retired educational evaluator; although fruitless, it also appears

harmless. Instead of engaging in a game of "same and different," the educational evaluator should become sufficiently conversant with the available models of evaluation to decide which, if any, to employ. Often, a more eclectic approach will be adopted whereby one selectively draws from the several available models those procedures or constructs that appear most helpful.

To aid in that regard, the remainder of this chapter will be devoted to a consideration of four general classes of educational evaluation models and to an analysis of particular models illustrating these four categories. Most of the models to be treated were developed during the late 1960s and early 1970s. For clarity of exposition and, hopefully, increased usefulness, an attempt has been made to sort out the various models according to their main emphases.

An alternative course of action would have been to describe each of a dozen or so models, then encourage the reader to conduct a personal appraisal of the different scheme. Another approach would have been to set out description of various models, then compare them on specific dimensions. This kind of analysis is available elsewhere. The approach used here was to isolate the overriding orientations inherent in the various model, then group the models under the most general descriptive categories to be employed here are these:

- Goal attainment models
- Judgement models emphasizing intrinsic criteria
- Judgemental models emphasizing extrinsic criteria
- Decision-facilitation models

Now, clearly, an effort to scrunch all current evaluation models into these four containers is bound to do violence to some of the models. Almost any *post-facto* classification scheme to handle theoretical models this sort of unlikely

to possess those exhaustive but nonoverlapping categories that make classification specialist tingle. Yet, albeit imperfect, this four-category system for viewing extant models of educational evaluation should provide the reader with a set of useful ways of thinking about the diverse evaluation models now on the market. Without some kind of structure for making sense out of this diversity, the danger of being overwhelmed by incomparability of the models is too great.

A goal-attainment model of educational evaluation conceives of evaluation chiefly as the determination of the degree to which an instructional programme's goals were achieved. More ancient in its lineage, the goal-attainment conception of educational evaluation is usually associated with the efforts of Ralph W. Tyler, whose approach to evaluation was reflected in the well-known Eight Year Study of the 1930s. During his extensive and illustrious career in education, Tyler has often spoken and written on his view of an appropriate framework for planning and conducting educational evaluations. The general approach recommended by Tyler involves the careful formulation of educational goals according to an analysis of three goal sources and two goal-screens. The resulting goals are then transformed into measurable objectives.

At the conclusion of an instructional programme, measurements of pupils are taken in order to see degree to which the previously established goal were achieved. Unattained goals reflect inadequacies in the instructional programme. Attained goals reflect a successful instructional programme. It is for this reason, of course, that the Tylerian approach to educational evaluation can be considered, in essence, a goal-attained model.

Tyler was one of the first proponents of behaviourally stated objectives, for he recognized that ill-

defined statement of objectives were little of use in an evaluation approach that hinged on detecting the degree to which a programme's objectives had been achieved. Although Tyler's standards regarding the requisite degree of specificity for objectives were less stringent than those employed by many of today's evaluators, the Tylerian tradition of educational evaluation had an enormous impact on the thinking of educators regarding the conduct of educational evaluations.

Even today, major evaluation projects such as the National Assessment of Educational Progress are firmly rooted in Tyler's conception of educational evaluation. Tyler recognizes, of course, that goals can be altered. Unattained goals, although permitting the inference that the instructional programme was ineffectual, might also result from an inappropriate selection of goals in the first place. But educational goals and the degree to which they are achieved, without question, constitute the heart of Tyler's evaluation approach. A more recent variation of the goal-attainment model is that proposed by Hammond who also conceives of evaluation in terms of whether an educational programme is "really effective in achieving its expressed objectives." The several steps in Hammond's model include:

1. isolating that aspect of the current educational programme to be evaluated.
2. defining the relevant institutional and instructional variables,
3. specifying objectives in behavioural terms,
4. assessing the behaviour described in the objectives, and
5. analyzing goal-attainment results.

Hammond's model goes to greater length in attempting to spell out the nature of the institutional and instructional factors that might be relevant in considering

the degree to which expressed objectives are achieved. The step of his recommended sequence of operations involves analyzing the relationship between these instructional and institutional variables as they bear on measured learner behaviour.

Another example of a goal-attainment model has been offered by Metfessel and Michael. Their approach consists of eight steps:

1. Involve members of the total community.
2. Construct broad goals and specific objectives.
3. Translate specific objectives into forms that are communicable and that facilitate learning.
4. Develop measurement instrumentation.
5. Carry out periodic measurement.
6. Analyze measurement data.
7. Interpret analyzed data.
8. Formulate recommendations for programme change or modified goals and objectives.

The most helpful part of the Metfessel and Michael approach is their effort to set forth different classes of criterion measures that might be employed to reflect the goal-attainment of an educational programme. Having recommended the use of multiple criterion measures, they provide a comprehensive list of diverse criterion measures that might be considered by evaluators. The reader who wishes to examine divergent conceptions of the measures used to reflect goal attainment should consult the Metfessel—Michael essay.

The review, the main thrust of goal-attainment models is the degree to which prespecified instructional goals have been achieved. The quality of those goals is, obviously, of considerable import. In the next chapter we shall treat the topic of educational goals in more detail.

Another class of models includes those in which major attention is given to *professional judgement*. In these approaches the evaluator exercises considerable influence on the nature of the evaluation, inasmuch as it is that evaluator's judgement that determines how favourable or unfavourable the evaluation turns out to be. But the particular focus of the evaluator's judgement permits us to subdivide this approach to evaluation further, depending on whether chief attention is given to *intrinsic criteria* or *extrinsic criteria*.

The distinction between intrinsic and extrinsic criteria is rather straight-forward. Suppose you are considering a number of electric drills with a view to purchasing one of them. You could judge them on the basis of such factors as their design, style, weight, and colour.

The criteria are *intrinsic* to the object to be judged. You could also judge them on the basis of such factors as how fast or how neatly they drilled holes. These criteria are *intrinsic* to the object to be judged. Extrinsic criteria are associated with the *effects* of the object. For instance, we might judge a textbook on its intrinsic features, such as whether it is well illustrated and colourfully designed, or we could judge it on its extrinsic effects, such as how well students can be learn something from it. Intrinsic criteria are often referred to as process criteria. Extrinsic criteria are often referred to as product criteria.

Judgemental approaches to educational evaluation in which the emphasis is on intrinsic criteria are very common in education, but most are too haphazard to be properly classified as instances of systematic educational evaluation. An exception to this, however, is the *accreditation* model of educational evaluation. Accreditation approaches to the evaluation of educational endeavours appear to be declining in popularity, but

there was a time when this approach represented perhaps the most prevalent form of systematic educational evaluation. Accreditation evaluations are typically carried on by associations of schools, such as the well-known-North Central Association. Representatives of the accrediting agency visit a school, and, on the basis of previously determined evaluative criteria, judge the school's programme. With few exceptions the dimensions of interest to accreditation terms have been intrinsic criteria, such as the number and quality of books in the school library, the degree of training of the school's faculty, or the physical plant.

Quite often, prior to their site visit, the accreditation agency directs the participating school to engage in an extended self-study in anticipation of the accreditation visit. Reports are prepared that are organized around the criteria supplied by the accreditation agency. Participants often report that these anticipatory activities represent one of the most useful aspects of accreditation evaluations. A major reason for the diminishing interest in accreditation conceptions of evaluation is the recognition of their almost total reliance on intrinsic rather than extrinsic criteria. Although there is some intuitive support for the proposition that these process factors are associated with the final outcomes of an instructional sequence, the scarcity of empirical evidence to confirm the relationship has created growing dissatisfaction with the accreditation approach among educators. Although few evaluators would recommend that intrinsic criteria be discounted completely in judgemental models, for these factors can sometimes help clarify what is really operate in a given programme, evaluation models that emphasize intrinsic criteria are not often recommended with fervour these days.

There are several approaches to educational evaluation recommended by evaluation theorists that can

best the described as judgemental schemes in which primary attention is given to extrinsic criteria, although they contain elements of the previously described models. The most significant of these models are those proposed by Michael Scriven, a philosopher, and Robert E. Stake, a psychometrician. Both men have contributed significantly to the understanding of the evaluation process as it applies to education.

What Professor Scriven has brought to educational evaluation is less a formal evaluative model, complete with diagrams, flow charts, and the other regalia typically spawned by model-builders, than a series of important insights and clarifications regarding varied aspects of educational evaluation. Yet, by summing these distinctions and explanations we can arrive at a rather cohesive framework for the conduct of educational evaluations. Hence it seems no major semantic distortion to deal with Scriven's recommendations in the context of considering contemporary evaluation models.

It has been previously noted that Scriven first drew or attention to the distinction in roles served by evaluators who *formatively* try to improve a still-under-development in structional sequence and evaluators who *summatively* assess the merits of already-completed instructional sequences.

The differences in partisanship exercised by formative and summative evaluators, not to mention their use of different procedures, have made this distinction a particularly influential one. Scriven's formative-summative distinction is widely used by today's educational evaluators, although in some cases with connotations somewhat different than those intended by Scriven.

Scriven conceives of evaluation as an assessment of merit. He is particularly dismayed with those who would

equate educational evaluation with the degree to which goals are achieved. He stresses the necessity to assess the merit of the goals themselves. As he points out, "...it is obvious that if the goals aren't worth achieving then it is uninteresting how well they are achieved." His recommendation, namely, that evaluators bring considerable attention to appraising the quality of goals as well as whether the goals have been achieved, has alerted evaluators to the impropriety of passively accepting any goals preferred by programme designers. For instance, if an autocratic school superintendent mandated a series of inhumane and antidemocratic goals, the evaluator should not meekly appraise the instructional programme in terms of whether those reprehensible goals were achieved. Scriven would recommend a more rigorous evaluation and, in this case, repudiation of the goals themselves.

Scriven describes an evaluation approach that focuses on extrinsic criteria as *payoff evaluation*. He contrasts this with *intrinsic evaluation*, which, as we have seen, attends more to the internal characteristics of an instructional programme.

Although Scriven tends to stress payoff evaluation rather than intrinsic evaluation, he is not disdainful of intrinsic evaluation. Indeed, he offers advice regarding how evaluators may engage in "hybrid evaluation, which combine attention to intrinsic and extrinsic criteria. He even argues against the possibility of pure payoff evaluation, suggesting that attention to intrinsic factors is almost inescapable.

An Emphasis on Comparative Evaluation: In his classic 1967 paper on evaluation methodology, Scriven distinguishes between comparative and noncomparative evaluation, the latter having been proposed several years earlier by Lee J. Cronbach in an essay regarding how to

improve instructional sequences via evaluation. Scriven opts for a comparative orientation to evaluation, pointing out that the decision focus of educational evaluation typically involves choices among competing alternatives, hence requiring comparisons of the competitors. Although conceding, as Cronbach contends, that comparative evaluations of educational programmes often make it difficult to understand what accounts for the differences among the programmes, Scriven observes that action decisions can be made without completely understanding why one programme is better than another. If, on the basis of a comparison of two reading programmes, the evaluator can show that one programme even without completely comprehending the reasons that it works better. It is the job of the educational researcher to ferret out the factors that lead to the more effective programme's superiority. The educational evaluator can make action recommendations without that information. Scriven's strong advocacy of comparative evaluation has made many evaluators approach their task by searching for reasonable comparisons among the objects they evaluate.

In the late sixties the federal government, sometimes because of legislative mandate and sometimes because of rational management practice, attempted to monitor the manner in which major financial resources were being spent on education. Much of this federal money was being used to support the newly created research and development centers, located at major universities throughout the nation, and the regional laboratories for educational research and development. Several of these enterprises were substantially funded operations with annual budgets running as high as two or three million dollars per year. The typical scheme employed to evaluate these and similar agencies involved the appointment of a group of individuals who constituted a

review team for each agency. The review team typically spent several days conducting a site visit at the agency, visiting with staff members and examining the reports and products developed by the agency. At the conclusion of the site visit, the review team would prepare a report evaluating the agency, then submit the report to the appropriate federal funding organization.

Because of his increasing visibility as an evaluation theorist Scriven was involved in a good many of these review teams. He detected an interesting phenomenon during his site visit, which constituted the chief data gathering phase of these evaluations. Almost without exception the review team commenced their work by requesting information regarding the agency's goals or the goals of the various subprojects within the agency. Almost every subsequent interaction between review-team members and the staff of the research and development agency was influenced significantly by these initial revelations regarding the agency's aims. So influential, in fact, was the review team's awareness of project goals that Scriven opined such goal-preoccupation might actually be interfering with the quality of the evaluator's work. He sensed that the evaluators' concern about the project's goals might, consciously or unconsciously, be leading to a form of tunnel-vision in which the review team was actually inattentive to those outcomes of an agency programme that, although not represented by the original intentions of the agency, were nonetheless real. To counteract these tendencies, Scriven proposed a technique he describes as *goal-free evaluation*.

In contrast to *goal-based evaluation* in which the evaluator is attentive to not only the quality of an educational programme's goals but also the degree to which those goals are achieved, *goal-free evaluation* focuses on the outcomes of a programme, intended as

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well as unanticipated. The goal-free evaluator is not concerned with the *rhetoric* of the instructional designers regarding what they want to accomplish. The goal-free evaluator attends to the *results* accomplished by the designers' programmes. Scriven is not recommending goal-free evaluation as a replacement for goal-based evaluation, but as a supplement to more goal-oriented frameworks. How does goal-free evaluation work? Well, in brief it consists of assiduously avoiding any "contaminating" knowledge regarding project goals, while trying to discern what the total effects of the project are. This is tricky job, since to figure out what a project's effects are without access to any information regarding its contents forces the evaluator to draw inferences about probable effects on the basis of inspecting the programmes components. Having drawn such inferences, then it is the evaluator's job to devise measures, or borrow them from the project where available, and assess the programme's effects. Scriven talks about the goal-free evaluator's "setting snares" to detect a programme's consequences. These snares or measurement schemes would obviously have to be contrived so as to pick up the programme consequences that in the view of the goal-free evaluator, would be most likely to occur.

The chief advantage of goal-free evaluation is that it encourages the evaluator to be attentive to a wider range of programme outcomes than might be the case with a goal-based evaluator who has been unduly influenced to look for project results consonant with project aims. Scriven conceives of goal-free evaluators functioning *internally* as well as *externally* to instructional projects. For instance, in a curriculum materials development project a goal-free internal evaluator who was a member of the project staff might, either formatively or summatively, assess the worth of various project endeavors in terms of

their result. Goal-free external evaluators, those who conducted their evaluations without being actual members of the instructional project's staff, could also prove useful in a summative or formative role. Ideally, a well-designed evaluation would have both goal-based and goal-free evaluators involved in the evaluative effort. If insufficient resources do not permit this luxury, then one must decide how to spend one's limited evaluation dollars. For instance, we might wish to utilize an internal goal-based evaluator whose focus was summative evaluation.

Goal-free evaluation, one of Scriven's many original contributions to evaluation theory, has not yet been used in enough settings to permit judgements regarding its efficacy. As an adjunct to more conventional approaches to evaluation, it would certainly seem to warrant attention.

Scriven has also introduced an additional technique, known as the *Modus Operandi Method*, which he believes will be of use to educational evaluators in certain situations where they are unable to use experimental or quasi-experimental approaches.

The *Modus Operandi Method* is fashioned after procedures employed by the detective, the historian, the anthropologist, and the electronics trouble-shooter. An extensive consideration of the *Modus Operandi Method* is, particularly in view of its neonate status, not appropriate here, but a brief sketch of its major elements may titillate the reader sufficiently to consult Scriven's more-detailed treatment.

The most common application of the *Modus Operandi* method would be to detect whether an intervention we are trying to evaluate is the cause of a set of effects judged to be desirable. The most common application of this procedure is in the field of crime

detection where the experienced police lieutenant instantly recognizes the modus operandi of burglar who typically breaks into office buildings via freight elevators and air-conditioning systems.

In autopsy analysis the coroner also employs a knowledge of M.O.'s associated with drowning, certain kinds of poisoning, and coronary attacks. As Scriven puts it, with characteristic philosophical precision: "The M.O. of a particular cause is an associated configuration of events, processes, or properties, usually time sequences, which can often be described as the *characteristic causal chain* connecting the cause with the effect."

The flavour of the Modus Operandi Method may be conveyed by one of the schemes Scriven suggests. In general we should try to discover whether a complete causal chain is present between the effect we have discerned and the intervention we are evaluating. We also have to see whether there are other complete causal chains that could serve to link the effect with other causes. For instance, the evaluator employing the Modus Operandi Method might observe an effect that possibly was caused by the instructional treatment to be evaluated. The evaluator should:

1. Check for the presence of each possible cause. If only one is present, then it is the cause.
2. If more than one possible cause is present, check for complete M.O.'s. If none are present, then none of the possible causes are, in fact, in cause.
3. If only one M.O. is complete, the possible cause associated with that M.O. is actually the cause.
4. If more than one complete M.O., is present, the possible causes associated with those M.O.'s are co-causes.

The conclusions of this kind of analysis are, of course,

probabilistic rather than definitive, yet evaluators must often assess merit, and identify its causes, with less than perfect certainty. Scriven's Modus Operandi Method will surely receive attention from evaluation specialists in the future, because in addition to representing an intriguing new evaluative tactic it can bring out the latent Sherlock Holmes in all of us.

In another important evaluative essay, Robert E. Stake proposed a system for conducting education evaluations in a 1967 article entitled "The Countenance of Education Evaluation." Because of the title of that essay, Stake's approach to evaluation is often referred to as his *Countenance Model*.

Stake's conception of evaluation emphasizes two chief operations, description and judgement. He sets forth a well-organized scheme for carrying out these two activities, drawing the reader's attention to several important considerations that should be needed by those who would describe and judge. One of the helpful aspects of the Countenance Model is that it distinguishes between descriptive and judgemental acts of the evaluator according to three phases of an educational programme, that is, its *antecedent*, *transaction*, and *outcome* phases. Stake conceives of antecedents as conditions existing prior to instruction that may relate to outcomes. He views transactions as the "succession of engagements" that constitute the process of instruction. Outcomes are considered to be the effects of an instructional programme. We shall illustrate each of these in a moment.

Stake then divides descriptive acts according to whether they refer to what was intended or what was actually observed. He argues that both in intentions and what actually took place must be fully described. He then divides judgemental acts according to whether they refer

to the standards used in reaching judgements or to the actual judgements themselves. He assumes the existence of some kind of rationale guiding the design of an educational programme. Stake combines these several distinctions in a graphic representation of the statements and data needed to be gathered by an evaluator. This layout is represented in figure.

Notice that, apart from the rationale, the six cells as the left of the layout refer to descriptive operations, whereas the six cells at the right deal with judgemental operations. We can illustrate the various dimensions of Stake's model by the following fictitious example regarding a high school government teacher, Mr. Vine:

Rationale

Mr. Vine has decided to emphasize the distinctions between functions of local, state, and federal government because he believes that these distinctions are pivotal in one's understanding of citizenship responsibilities.

Intents

Antecedents: Mr. Vine knows that chapter 9 has been assigned for Tuesday.

Transactions: He plans to have a lecture plus discussion on Tuesday.

Outcomes: He estimates what students will be able to do on a quiz Wednesday.

Observations

Antecedents: He observes that six students were absent on Tuesday.

Transactions. His lecture took so long that there was little for discussion.

Outcomes. On Wednesday's quiz well over half the students answered an important question incorrectly.

Standards:

Antecedents: He expects a few absences on non-quiz days such as Tuesday.

Transactions: He believes his lectures are clear enough for 80 per cent of the class to understand them.

Outcomes: His fellow government teachers believe three-fourths of their students should do well on these kinds of quizzes.

Juagements

Antecedents: Mr. Vine retrospectively judges the chapter 9 reading assignment to be somewhat confusing.

Transactions: Several of his weaker students told him his lecture was unclear.

Outcomes: A teacher's aid assigned to grade the quiz papers said too many students performed poorly on the quiz.

Stake's data matrices help us to see how his model inclines the evaluator to engage continually in description and judgement, *at the beginning, during, and at the end* of an educational programme. His distinction between intents and observations reminds us how the aspirations of educators are often realized in the antecedents, transactions, and outcomes that actually occur.

Stake's Countenance Model also elaborates on the manner in which judgements are made by evaluators. He points out that when we judge an educational programme we engage either in relative comparisons, absolute comparisons, or both relative and absolute comparisons. Stake recommends that the judgemental criteria used in educational evaluations be explicated as clearly as possible prior to employing them in actual judgements.

After devising his 1967 Countenance Model, Stake became more attuned to discovering what the evaluator's clients actually want. He argues us to discover these concerns prior to designing an evaluation project. He recommends a responsive evaluation stance in which great attention is given to the description and judgement needs of those who commission the conduct of an evaluation. Stake believes that insensitivity to the perceive needs of those individuals from whom an evaluation is being conducted will lead to an unresponsive, hence futile evaluation.

Both Scriven and Stake as proponents of judgmental models believe that the capable evaluator will be able to make subtle judgements about various facets of an educational programme. Although their emphasis is on judgement of extrinsic criteria, it should be obvious that their models reflect considerable concern with a number of additional factors.

Several evaluation paradigms have been proposed that, although they involve the evaluator's use of judgement and determine whether goals are attained can best be characterized as *decision-facilitation models*. The orientation of these models is so overwhelmingly toward servicing educational decision-makers that some of their proponents conceive of the evaluator as the decision-maker's handmaiden/handmister.

In a good many respects, one might argue, there is overlap between these decision-facilitation models and the three classes of evaluation models we have previously examined, that is, goal-attainment models, judgemental models emphasizing intrinsic criteria, and judgemental models emphasizing extrinsic criteria. Although this is true, there is an important difference. Decision-facilitation evaluators are less willing to assess personally the worth of educational phenomenon. They

will strive to collect and present the information needed by someone else who will determine worth. Decision-facilitation evaluators view the final determination of merit as the decision-maker's province, not theirs. Although it is obvious that decision-facilitation evaluators cannot completely avoid engaging in worth-determination acts as they ply their trade, it is this overriding disinclination to engage in personal valuing, coupled with their mission to abet the decision-maker's task, that renders them at least relatively distinct from the other approaches we have treated.

One of the best known of the decision-facilitation evaluation schemes is the CIPP Model. CIPP is an acronym representing the four types of evaluation this model identifies, namely, *context* evaluation, *input* evaluation, *process* evaluation and *product* evaluation. The CIPP Model was originated by Daniel Stufflebeam and Egon Guba. The fact that it has become well known in spite of the fantasy-like names of its parents strongly suggests the approach must possess some merit. Because Stufflebeam has been more active in refining the CIPP Model during recent years, we shall use his writings as a chief source of our analysis.

The CIPP Definition of Evaluation: The CIPP approach to evaluation is rooted in its definition of evaluation: Evaluation is the process of delineating, obtaining, and providing useful information for judging decision alternatives.

Stufflebeam elaborates on this definition by pointing out that "*Since evaluation is performed in the service of decision making,*" it should emphasize the provision of information useful to those who must make decisions. Because evaluation is a continuing and cyclic process, it must be implemented via a systematic programme. Stufflebeam believes that of the three steps involved in this model, that is, *delineating, obtaining, and providing*

information, the delineating and providing operations are carried out collaboratively between evaluator and decision-maker, whereas the obtaining of information is a technical activity carried out primarily by the evaluator.

These three major steps in the CIPP evaluation process are described as follows:

1. *delineating* refers to the focusing of informative requirements needed by decision-makers through such operations as specifying, defining, and explicating;
2. *obtaining* refers to the collection, organization, and analysis of information using such technical procedures as measurement and statistics;
3. *providing* refers to the synthesizing of information so that it will be optimally useful for purposes of the evaluation.

Note that all the three steps involve *information* and how it can best be isolated, gathered, and presented to those people who make educational decisions.

Decision Settings: The CIPP model also distinguishes among different settings in which decisions are made. Decisions that involve maintenance of the normal balance of an educational system are described as *homeostatic*. Homeostatic decision making would involve such operations as determining faculty assignments or students' course schedules. Decisions that involve developmental activities aimed at the continuous improvement of a programme are described as *incremental*. Incremental decision making would include such operations as the introduction of a model innovative programme that would not run the risk of a major expense or a major failure. Decisions that involve large innovative efforts to solve significant problems are described as *neomobilistic*. Neomobilistic decision making

would include such activities as major governmentally subsidized efforts to develop instructional materials, such as those now being prepared at several regional laboratories for educational research and development. Decisions that denote utopian activity designed to produce complete changes in an educational enterprise are described as *metamorphic*. The CIPP Model-makers concede that a metamorphic decision setting is only of theoretical interests, as the possibilities of this type of dramatic system-modification is almost never encountered in the real world to education.

One clear contribution of the CIPP Model is that it augments the evaluator's vocabulary. Just think of how many school superintendents could be intimidated by an evaluator's assertion that "Your programme is utterly neomobilistic!" Early users of the CIPP Model sometimes thought that neomobilism referred to that stage of adolescence associated with the onset of driving privileges.

Types of Evaluation: The CIPP Model, in addition to identifying several decision settings, also distinguishes among four types of educational decisions. These are (1) planning decisions to determine objectives, (2) structuring decisions to design instructional procedures, (3) implementing decisions to use, monitor, and improve these procedures, and (4) recycling decisions to judge and react to the outcomes produced by those procedures. For each of these different types of decisions, a corresponding type of evaluation is recommended, namely: context, input, process, and product. These four forms of evaluation constitute the heart of the CIPP Model.

Context evaluation, according to Stufflebeam, the most basic kind of evaluation. Its mission is to provide a rationale for the determination of educational objectives. A context evaluation attempts to isolate the problems or

unmet needs in an educational setting. Consideration of such factors then leads to the identification of the general goals and specific objectives that should be the focus of an educational programme.

Context evaluation involves an analytic effort to conceptualize the relevant elements of an educational environment, as well as an effort to gather empirical data that help identify the problems, needs, and opportunities present in an educational context. The methods of context evaluation are chiefly descriptive and comparative. The context evaluator describes the status of an educational setting, then compares present, probable, and possible system outputs. The conclusion of context evaluation is characteristically the identification of a set of specific objectives for which an instructional programme can be designed.

Input evaluation is supposed to provide information regarding how to employ resources to achieve programme objectives. During input evaluation the task is to ascertain the nature of available capabilities of the instructional system and potential strategies for achieving the objectives identified as a consequence of context evaluation. The input evaluator secures information needed to appraise alternative strategies, whether they are based on the system's current capabilities or whether external resources need to be added to the system. Input evaluators help decision-makers select and design the procedures deemed suitable for promoting attainment of programme goals. for instance, if a set of programme objectives had been selected that revolved around learner mastery of certain chemistry objectives, then the input evaluator's tasks would be to delineate, obtain, and provide information needed for decisions regarding which instructional resources to use and in what manner they should be employed in order to promote achievement of the objectives identified.

Process evaluation is required once the instructional programme is up and running. The purpose of process evaluation is up and running. The purpose of process evaluation is to identify any defects in the procedural design, particularly in the sense that planned elements of the instructional programme are not being implemented as they were originally conceived. The process evaluator describes procedural events and activities so that any deficits in the instructional design can be discerned, or, in some cases, anticipated. The records made by the process evaluator are also useful in retrospective analyses of the instructional programme in order to isolate any particular strengths or weaknesses. In essence, process evaluators monitor the actual instructional procedures in order to help the instructional decision-makers anticipate and overcome procedural difficulties.

Product evaluation attempts to measure and interpret the attainments yielded by an instructional programme not only at its conclusion but, as often as necessary, during the programme itself. The methods of product evaluation are similar to those of the goal-attainment evaluator and the judgemental evaluator who emphasize extrinsic criteria, except that the CIPP product evaluator, as always, delineates, obtains and provides information needed by those who must make decisions regarding the programme. The emphasis in product evaluation, however, is clearly on the outcomes related to the objectives of the programme, then comparisons are made between expectations and actual results. The product evaluator helps others decide whether to continue, terminate, modify or refocus an instructional programme.

These four types of evaluation, cast as they are in a decision-facilitation framework, constitute a fairly full-blown model, particularly when they are viewed in relationship to the types of decision settings previously examined. Several years ago, shortly after the CIPP

Model was conceived diagrammatic flow charts of the scheme, replete with its multiple destinations, inspired awe on the part of many neophyte evaluators.

CIPP and the Formative-Summative Distinction: Stufflebeam has attempted to relate the CIPP Model to Scriven's formative and summative evaluation. In reconciling these constructs, Stufflebeam distinguishes between *evaluation for decision making* and *evaluation for accountability*. He believes that when evaluation serves a formative role it is *proactive* and is aimed at abetting decision-makers when, however, evaluation serves a summative role it is *retroactive* in nature and is aimed to serve as a basis for accountability.

Stufflebeam's attempted reconciliation can be presented pictorially where it can be seen that the key distinction is based on whether the evaluation is *formative*, hence before-the-fact and aimed at the needs of decisions-makers, or *summative*, hence after-the-fact and aimed at the needs of an accountability system.

The CIPP Model provided the first full-blown framework to guide those evaluators who saw their mission chiefly as one of helping those who must make educational decisions. Stufflebeam, Guba, and their colleagues reflect this bias succinctly in the introduction to their 1971 volume describing their approach: "*The purpose of evaluation is not to prove but to improve*."

The UCLA Centre for the Study of Evaluation (CSE) is a research and development center devoted to the analysis and improvement of educational evaluation practice. The center's approach to evaluation, most completely described by its director, Marvin C. Alkin, is usually referred to as the CSE Model. The CSE model also is highly attentive to the requirements of those who must make educational decisions, as is indicated in the definition of evaluation provided by the model.

Evaluation is the process of determining the kinds of decisions that have to be made; selecting, and analyzing the information needed in making these decisions; and reporting this information to appropriate decision-makers.

As Alkin has pointed out, the CSE Model is similar to the CIPP Model except that what Stufflebeam refers to as *process evaluation* has been substantially reconceptualized. Whereas the CIPP evaluator focuses on procedural considerations during process evaluation, the CSE Model encourages evaluators to attend to the enroute *products* as well as *process* of the programme being evaluated. The CSE approach is more explicitly tied to the different kinds of decisions to be made at each of five stages. Let's consider these stages and their associated decision foci.

Needs Assessment: The initial stage of the CSE Model focuses on the provision of information regarding the extent to which educational programmes are meeting their objectives. An attempt is made to ascertain the current status of an educational programme's outputs, then this status is contrasted with desired programme outcomes. The difference between what is and what is desired is described as an educational need, and is used to identify educational goals. The decision focus of this first stage of the CSE Model is *problem selection*.

Programme Planning: The second stage of the CSE Model provides information regarding the sorts of instructional programmes that meet the needs identified during the needs-assessment stage. For example, an evaluator engaged in this activity might apprise the degree to which purported objectives of commercially developed instructional materials meshed with the objectives derived from the previously conducted needs assessment. The decision focus of programme planning, therefore, is *programme selection*.

Implementation Evaluation: After programme planning, the CSE evaluation would provide information on the degree to which the instructional programme is actually being carried out in accordance with the programme plan. The necessity for monitoring the degree to which a programme coincides with the programme design arises from the frequent departures from designs by those who carry out a programme. This stage of the CSE approach is most akin to CIPP's process evaluation. The decision focus of the implementation evaluation stage of CSE Model is *programme modification*.

Progress Evaluation. The fourth stage of the CSE scheme provides information regarding the extent to which the planned programme is achieving its objectives. The evaluator is, in this phase of the CSE Model, clearly an interventionist. The progress evaluator tries to identify the relative success of the different components of a programme with a view to improving deficiencies in the programme. Unlike their CIPP counterparts, however, CSE evaluators are attentive to the en-route *product* of the programme at this stage. This represents a clear distinction between the CIPP and CSE approaches. As with implementation evaluation, the decision focus of progress evaluation is *programme modification*.

Outcome Evaluation. As implied by its title, the final stage of the CSE Model emphasizes the provision of information regarding the general worth of the programme as reflected by the outcomes it produces. Information regarding the extent to which the objectives have been achieved is obviously significant. The outcome evaluator wants to present information to decision-makers so that they can determine whether a programme should be eliminated, modified, retained, or disseminated more widely. The decision focus of the final stage of the CSE Model is *programme certification/adoption*.

A comparison of the CSE and the CIPP Models will reveal several similarities, particularly with respect to the first two stages of each model. Although there are basic similarities between these major components of the two approaches, there are also important differences that will become even more pronounced as Stufflebeam and his associates sharpen the CIPP Model and Alkin and his colleagues refine the CSE Model. One of the important features associated with the CSE Model is that its proponents have developed a wide range of instructional materials, and other resources, designed for groups and individual self-study, to familiarize educators with the ingredients of the CSE approach. The widespread use of these materials would suggest that the CSE Model currently influences actual evaluation practice as much as any of the model considered here. For example, several firms specializing in evaluation by contract organize their services around the CSE Model. Information regarding materials descriptive of the CSE approach can be secured from the Center for the Study of Evaluation.

Malcolm Provus, during his tenure as Director of Research for the Pittsburgh public schools, devised another systematic approach to evaluation based on the premise that evaluation involves the comparison of *performance* with *standares*. Because Provus' model is particularly attentive to the discrepancies between posited standards and actual performance, it is generally referred to as the *Discrepancy Model* of educational evaluation. More specially, Provus offers the following definition of evaluation:

Programme evaluation is the process of

1. defining programme standards;
2. determining whether a discrepancy exists between some aspect of programme performance and the standards governing that aspect of the programme; and

3. using discrepancy information either change performance or to change programme standards.

Design. The first stage of the Discrepancy Model is the design stage. This operation is focused on documenting the nature of the programme including

1. the objectives of the programme,
2. the students, staff, and other resources that must be present before programme objectives can be realized, and
3. the instructional activities presumed to promote attainment of the objectives.

In rough terms, the activities associated with this stage are comparable to those seen in the first two stages of the CIPP and CSE Models.

Installation. The second stage of the Discrepancy Model involves an effort to see whether an installed programme is congruent with its installation plans. The programme design emerging from stage 1 represents the standards (S) against which the programme (P) is compared (C) to detect the presence or absence of discrepancies (D). The usual four choices of action are available to the programme's decision-makers, that is, terminate, proceed, alter performance, or alter standards. This stage is similar to the CSE Model's implementation evaluation stage.

Process. In the third stage of the Discrepancy Model the evaluator attends to the question of whether "enabling objectives" are being achieved. The evaluators' role here is similar to Scriven's formative evaluator, to CIPP's process evaluator, or to CSE's implementation or progress evaluator. The usual Discrepancy Model paradigm is used involving comparison between standards and performance with resulting discrepancy information guiding decision-makers.

Products. The fourth stage of the Discrepancy Model is focused on the question: "Has the programme achieved its terminal objectives?" The standards derived during stage I are contrasted with the actual post-instruction performance of learners to detect any discrepancies. This stage involves activities comparable to those employed during the final stages of the CIPP and CSE Models.

Programme Comparison. The final stage of the Discrepancy Model unlike the first four, which are developmental in nature, is concerned with a cost-benefit analysis of the now-completed programme with other competing programmes. Provus properly points out that unless there is a sufficient degree of replicability associated with the programmes to be contrasted, such cost-benefit analyses are impossible.

As can be seen from a comparison of the Discrepancy Model with the two decision-facilitation models previously examined, there is much similarity among these three evaluation frameworks. Because they all subscribe to the same general conception of evaluation's function, this is not surprising. As Provus observes, "those responsible for making decisions about one or more programmes are the first and primary audience for evaluative information." The decision-facilitation evaluative models conceive of the educational evaluation as a purveyor of the information needed by the decision-maker. As a collection of highly related approaches they have reminded educators of the major decision orientation that evaluation must display if it is to make a real difference in the nature of educational practice.

Model muddling

The descriptions provided in this chapter of the most prominent contemporary conceptions of evaluation will, hopefully, have accomplished several missions. For those

who only wish an overview of the approaches currently espoused by different evaluators, the descriptions given herein may be sufficient. For those readers whose appetites have been whetted for a more intensive pursuit of one or more of these approaches, the brief accounts may serve as introductions.

One of the best collections of essays pertinent to these models is the recent book of readings compiled by Worthen and Sanders. The Worthen and Sanders volume also contain an excellent point-by-point comparison of many of the models described here.

It should also be apparent that the four-category classification scheme presented here must sometimes be bent a bit, in order to account tidily for some of the actual differences witnessed in the particular models. In general, however, the four categories seem serviceable, i.e., goal-attainment models, judgemental models emphasizing intrinsic criteria, judgemental models emphasizing extrinsic criteria, and decision-facilitation models.

Finally, for those who derive special raptures from engaging in model-comparisons, the instructions supplied here will help circumscribe the different models' boundaries. It should be apparent, of course, that a builder of evaluation models has a difficult time subscribing to Polonius' admonition, "Neither a borrower nor a lender be." But although the effective evaluator will hopefully avoid the perils of becoming preoccupied with model minutia, these diverse approaches to the task of educational evaluation are obviously instructive. To proceed without modest conversance with their major elements would be foolhardy.

3

Lifelong Learning

The recently launched University for Industry (Ufi) is informed and guided by the recognition that the 'failure of successive governments to convince small employers of the need to ensure continuing education and training for their workforce has been the biggest obstacle to efforts to keep Britain internationally competitive'. Deficiencies in British education and training have been a cause, "for concern for policy-makers for 150 years. Partly in response to worldwide recognition of the importance of lifelong learning, there has been a flurry of reforms in the last ten years. The result has been an array of short-term and narrowly focused initiatives which have confused rather than clarified the situation for the learner.

After all these efforts it remains the case that 'in general, small firms are much less likely either to provide training or to have a training plan'. Similarly, having failed to convince some of the larger employers, notably Peugeot and also Powergen and Jaguar, of the value of participating in the 'New Deal' initiatives for unemployed 18-24 year olds, the new administration is relying on charities and 'regional champions' drawn from leading British companies to stimulate interest in the Welfare to Work scheme amongst SMEs.

The seminal role accorded to SMEs—quite properly in view of the fact that they account for around 95

percent of British firms and 35 percent of total employment makes it vital to get VET policy, theory and practice right in this area.

There is a dearth of research on the attitudes to training and the specific needs and requirements of SME owner/managers. Our own research in this sphere—involving a national survey and telephone interviews with over 2000 owner/managers of small firms in the West Midlands region—was specifically designed to identify the motivations, needs, attitudes and take-up of training within SMEs.

The role of national vocational qualifications (NVQs)—especially in view of the recent dominance of the NCVQ agenda for VET and the position being accorded to reconstructed NVQs under the aegis of the new Qualifications and Curriculum Authority—was an important supplementary feature of our study, and we will locate our findings against the background of the function and role that NVQs might have in the new VET policies.

During the 1993-96 period we undertook a survey of training needs, skill formation and competitiveness in SMEs. The research consisted of a telephone survey covering 2000 randomly selected private sector SMEs supported by the findings from 246 in-depth semi-structured interviews with owner/managers and 74 detailed case studies of SMEs.

Many writers on the topic of training in the SME sector tend to concentrate upon the firm as a whole, thus neglecting the vital pivotal role that owner/managers invariably play in this type of establishment. Increasingly, however, a number of commentators have acknowledged the central role that owner/managers take in the day-to-day running of their firms, and recent

European research has linked company performance directly with owner/managers' capabilities.

We found that in most cases owner/managers were directly involved in all the aspects of the decision-making processes related to management functions in general and to training and human resource development strategies in particular.

Across all sectors of economic activity, owner/managers seem to retain a monopoly on training decisions. For example, in the 1,556 micro-firms (Band Code A and B) training and related issues were dealt with exclusively by owner/managers.

In very small businesses there were only 13 firms in which personnel managers were implicated in training-related decision making processes: key personnel and other employees were not represented in this size-band.

A larger proportion of personnel managers (16.42 percent) were involved in training-related decisions in firms employing between 20-49 individuals (Band Code D). In only 7 of the 44 firms with 50-99 employees (Band Code E) did key personnel—such as line managers—become concerned with the training process, to the apparent detriment of personnel managers (only one case reported). Interestingly, in small businesses, apart from personnel managers and key employees, no other staff appear to have been involved in training-related decisions.

Having established the extent of owner/managers' monopoly on training-related decision-making processes we set out to measure their attitudes to training. Respondents were offered a five-point self-assessing attitudinal scale, ranging from very negative to very positive, and invited to express their attitudes to training.

Significantly, the great majority of owner/managers claimed to have either a positive or very positive attitude to training (a factor which served to generate what we refer to as the 'paradox of training'). Actual provision of training within the firms in the research sample was also measured, cumulatively in each firm, for a period of up to one year preceding the date of the survey which was completed in 1996. The key finding in this area was the great majority of respondents across all five occupational sectors admitted that they had not provided any training during the preceding 12 months.

There exists an apparent paradox between the owner/managers' attitude to, and the actual provision of, training in the SME sector of the West Midlands region. For example, in the manufacturing sector 82.70 percent of respondents claimed to have a positive attitude to training, while a further 2.14 percent professed to hold a very positive attitude towards it. At the same time, 86.37 percent of owner/managers failed to provide any training during the previous 12 months period. Likewise, in the service sector, 91.15 percent of owner/manager claimed to hold positive and a further 1.75 percent very positive attitudes towards training. Yet, over the previous year, 81.16 percent of the owner/managers interviewed chose not to provide any training in their firms. Similar trends were found in the construction, agriculture and forestry/fisheries sectors.

Owner/managers were also asked to indicate the main factors that influenced the provision of training in their firms. Interestingly, they identified two different types of factor which apparently influenced their training-related decision-making processes: 'directly' and 'indirectly relevant'. 'Directly relevant' factors, such as the market positioning of a firm, prevailing economic conditions and the availability of relevant training, were

deemed to be of primary importance to the decision-making process of owner/managers in the sample. 'Indirectly relevant' factors were of secondary importance to the human resource development strategies of these owner/managers, but still exerted a considerable influence upon the quantity and quality of the training provision in their firms.

Prominent in the indirectly relevant category were the cost of training, time constraints, lack of in-house trainers and factors related to trainee cover, motivation and interest. In addition, it is worth mentioning the special significance of the 'incubator' training of owner/managers—based on their own experiences and current perceptions of VET—which our survey highlighted in common with other studies of SMEs. *Prima facie* it appears that recent policy efforts aimed at the SME sector have failed to make a significant impact upon these owner/managers' training and human resource development strategies. The low uptake of NVQs in this sector poses a serious challenge to claims that this approach to training is 'employer-led' and/or that it is one of the most successful to date. In contrast to such claims, in our randomly selected sample of SMEs, owner/managers' awareness and interest as well as the actual uptake rate of NVQs was shown to be still disappointingly low, a finding which reinforces those of other recent surveys.

Typically, owner/manager awareness of NVQs increases considerably with the size of their firms. Nevertheless, overall awareness remains very low amongst micro-firms which, numerically in a typical random sample, represents the largest size-class. Take-up of NVQs in this large group of micro-firms in which only 0.56 percent and 0.96 percent of owner/managers had seen any merit in pursuing the dominant system must be

especially worrying for those whose New Deal plans envisage a major role for such firms.

The rhetoric underpinning government policies on lifelong learning has not only survived the shift from a Conservative to a Labour Administration but also remained virtually unchanged over the last decade or so.

The central message is well summed up in the slogan which introduced the updated National Education and Training Targets (NIETs): 'Developing skills for a successful future' with the aim of 'improving the UK's international competitiveness by raising standards and attainment levels in education and training to world class levels'.

According to the Department for Education and Employment (DfEE) account of VET requirements, learning is the 'key to successful economic development' since 'we need an increasingly skilled workforce to survive as a major economic power'. In a similar vein, in his Comments on the recent Green Paper on lifelong learning, the Education Secretary, David Blunkett **observes that:**

In the 21st century learning at different stages in life will be essential as human capital becomes to the information revolution what fixed capital was to the industrial revolution. For individuals who want security in employment and a nation that must compete worldwide, learning is the key. Such sentiments, though understandably shared by most commentators on all sides of education and industry, present a 'motherhood and apple pie' conception of the links between economic performance and investment in VET which is vague, nebulous and simplistic. Although there is some evidence that 'learning pays' in terms of private rates of return to individuals, the links between educational investment and socioeconomic outputs are hugely complex and

equivocal as, indeed, are the connections between skills development and industrial performance. It is misleading to suggest that any kind of expansion of or investment in education and training must without further qualification and specification be socially or economically advantageous.

Dore's pertinent investigation of the 'diploma disease' over twenty years ago has recently been updated to take account of intervening curricular and assessment changes. Disappointingly, however, and in spite of two decades of hectic educational change and development, the 'maladie du diplome' is still with us, as participation in further and higher education is expanded in the 'belief that Britain's competitiveness would be improved if we kept as large a proportion of 18-21 year-olds in full-time education as the USA and Japan'. Not only is this justification of post-school expansion based on very dubious evidence, it also leads to a highly undesirable 'qualification inflation' and a concentration on certification at the expense of genuine education and training.

What Dore means by 'genuine' education and training is that form of activity which is either intrinsically justified in terms of individual and/or sociocultural development or extrinsically linked to specific occupational/ professional requirements.

The indiscriminating expansion of post-school education and training per se runs the risk of satisfying neither of these requirements, just as the unsystematic scramble for upgrading workforce skills—described as the 'skills mirage' by some commentators—has had virtually no impact on the UK economic growth or unemployment rates. In any 1 case, the NTETS are concerned with the achievement of certificates, not with knowledge and skills and, as Amley argues, this strategy

can lead only to a 'certified and not a learning society' characterised by 'chronic qualification inflation and diploma devaluation'.

Perhaps more important than all this—especially in view of the long-standing financial and ideological support given to the system by the DfEE—is the failure of the NCVQ strategy to achieve either its own internal objectives or to supply the wider needs of British industry. Not only have NVQs failed to address the needs of industry and employees, it seems that the 'more employers know about the NVQs, the less they like them'. The Beaumont review of the top one hundred NVQs reported that, although 90 percent of respondents would give credence only to NVQs gained through employment-based training, only around 25 percent of all NVQs were awarded via this route. Perhaps it is now time that, in accordance with the original 1986 NCVQ remit and as recommended in the 1994 CBI report *Quality Assessed*, NVQs were returned to the workplace and removed from all programmes in colleges and non-workplace institutions. In this way, employers' expressed preferences for VET programmes and qualifications which are linked closely to workplace practice might be satisfied.

Such a reconstruction of the original NCVQ agenda might even go some way to restoring the links between national training efforts and industrial needs and skill shortages. In spite of the extravagant claims made by the NCVQ public relations machine, Robinson's survey indicated that the qualifications had penetrated only around 3 or 4 percent of the total workforce. The most recent NVQ data survey indicates that, on a sample of 4,200 business sites, the take-up (note, not the completion) of NVQs amongst firms employing less than 200 people (accounting for around 70 percent of total employment) was no more than 150,000. The vast

majority of this take-up was in business services, hotel and catering spheres (over 70 percent of the total) with the engineering and manufacturing sectors lagging way behind (and even these figures are optimistic compared with our own research cited earlier). This confirms Field's observation that—apart from the fact that 90 percent of all NVQs are awarded at the lowest levels—most of the certificates tend to be in business and service sectors 'where labour supply has been perfectly adequate for some years'. Moreover, most NVQs relate to 'skill areas with little or no connection with the manufacturing sector' and, thus, 'NVQs' contribution towards the identified shortages of intermediate skills, especially in technician and engineering occupations, is negligible'.

The majority of SME owner/managers across the five economic sectors investigated in our survey complained about the dearth of training schemes—especially within the remit of the dominant NCVQ system - relevant to their particular needs, a finding also reported in recent studies of modern apprenticeships and training credits. In the light of such findings, the recent report on the Youth Training and Training for Work schemes administered through TECs which indicated that, although fewer candidates were gaining NVQs, more people were getting jobs can, perhaps, be given a cautious welcome. What is required is a concentration on skills—ideally those linked to the skills gap between current employee skills and business objectives reported by 18 percent of employers in a recent survey—rather than certificates, and work-based as opposed to college-based VET might go some way to remedying such serious failings and weaknesses in the national system, particularly as the demise of the NCVQ now permits a major review and restructuring of vocational qualifications under the QCA.

Our research points up that the cost of training is a key determinant of its take-up in SMEs. The cost of work-based NVQs is already much higher than college-based routes and it is increasingly difficult for SMEs to bear any further costs arising from strategies designed to address the anomalies and shortcomings reported in a spate of recent critical studies. Employers, especially those in the SME sector, cannot be expected to pay for the design faults of an NVQ system which are not of their own making and often far from their specific business interests.

The plans for learning accounts for trainees and the Learning Bank through which government would supplement employers' investment in training for individuals—as originally floated by the Commission on Social Justice—might solve some of the problems of under-funding and stimulating investment in this sphere. However, although the national plan to kick-start this public/private partnership with one million accounts of up to £150 each will target 'people in low-skill jobs, areas of skills shortage' and 'employees in small firms', on past experience such amounts are unlikely to be enough to attract SMEs in sufficient numbers. Moreover, it will be crucial to take note of the special needs of SMEs and not repeat former mistakes of tying training plans and funding too closely to the achievement of specified NVQ outcomes which are often irrelevant to current industrial demands.

The training market has failed to attract SMEs or to cater for their specific needs and, after decades of government initiatives from the Manpower Services Commission (MSC) schemes in the 1970s to the White Papers on Competitiveness in the 1990s, it is still the case that they 'lack a full appreciation of the value of different types of learning' with 'owners and managers reluctant to invest in training because in the short-term the costs of

training are more apparent than the benefits'. Finegold & Levine's macro-analysis of market failure in this respect reported that:

one of the foremost barriers to raising investment in human capital is good information about the supply and demand for skills and the effectiveness of current employment and training programmes.

They suggest the improvement of networks of information to help companies identify 'what works at work' and, acknowledging this problem, one of the key UFI objectives is to expand significantly 'investment in the provision and upgrading of infrastructure, particularly broadband and interactive networks' for all companies. In a similar vein, the recent Fryer committee report on lifelong learning noted that the 'provision of up-to-date, accessible and impartial information and advice will be essential if a strategy of lifelong learning for all is to be successful'.

The UFI emphasis on exploiting existing 'local learning centres'—such as libraries, colleges, community and shopping centres—to provide work-based learning data would not only enhance choice and access for users but also, it is claimed, help to drive down costs through 'financial concessions and economies of scale'. Another vital element in cost-benefit analysis for SMEs—particularly as work-based learning is increasingly linked to providing training places in skill shortage areas or for the unemployed will be the need to reduce employer costs by adopting strategies such as those recommended by Booth & Snower involving the linking of training subsidies with the whole spectrum of state benefits. This is already being done by the new Labour administration in the form of encouraging single mothers back into work and with the 'New Deal' for unemployed 18-24 year olds which will build on 'local partnerships'—the Employment Service, Training and Enterprise Councils,

employers and education and training providers - and seek to 'ensure that value for money and quality are secured'.

SMEs cannot reasonably be expected to participate in such a scheme without adequate financial incentives, and it remains to be seen whether the current proposals—involving a subsidy to employers of £60 per week if they offer trainees 'an average of at least 30 hours' work a week, including the equivalent of one day a week's training'—will be attractive enough to small firms. The costs of training in such schemes cannot be separated from the specific skill requirements of SMEs and the links with the wider skills market.

Finegold & Irvine point out that training programmes targeted principally at disadvantaged groups—which have radically different objectives from schemes concerned with the mainstream workforce—consume the vast majority of public training expenditure in advanced industrial economies yet 'are often only marginally related to the skill needs of most employers'. Training under the New Deal initiatives will be largely of the former type aimed at disadvantaged groups and, thus, the quite proper emphasis on quality and standards urged by Finegold and Irvine and given priority in the New Deal proposals will call for close examination within the context of the SME sector.

One of the key findings of our SME survey was the importance of the past experiences and current perceptions of VET on the part of owner/managers. Negative experiences of training and perceptions of low-quality schemes reported in a large number of surveys are bound to discourage owner/managers from viewing employee training as a sound investment. The crucial importance of such 'incubator' experiences of training amongst SME owner managers—on both a

personal level and in terms of the general health of the national VET system—must, therefore, assume a central place in general policy in this area.

Unfortunately, the cause of upgrading VET and establishing high standards and a prestigious system of vocational qualifications has been severely damaged by the policy of determining and interpreting all strategies in terms of a rigid and prescriptive NCVQ agenda. In addition to the shortcomings already noted, the combination of an NVQ outcomes framework with a post-school funding regime which rewards successful outputs has resulted in assessment abuses on an unprecedented scale in recent years. Studies by the educational human rights charity Article 26 and by the Public Accounts Committee have revealed widespread fraud and corruption in the assessment and award of NVQs. It is difficult to see how this position can be improved without abandoning certain fundamental NCVQ principles with, as the QCA review indicates, the immediate strengthening of external assessment and verification procedures to be regarded as a top priority.

Computer/Internet Anxiety in the Classroom

The Internet, which allows people to communicate through their computers, no matter the location, has become and still is becoming a global phenomenon of impressive proportions. One of the most well known aspects of the Net is the World Wide Web which is defined as "a convergence of computational concepts for presenting and linking information dispersed across the Internet in an easily accessible way". This linking is responsible for the nonsequential properties of the system that affords people a high degree of choice when traveling through it. From its limited and covert beginnings as a cold war communications system, the Internet has now grown to serve over twenty-one million households. It is thought that the numbers will grow as new technologies come into play such as a digital system, offering a new level of access, and Netscape, providing a new level of security which should entice individuals and businesses to conduct more and more transactions on the Net. Thus, the Internet is a technology that is becoming indelibly interwoven into society and unfortunately, one that will antiquate those individuals who do not learn to maneuver in cyberspace.

Although the cognitive aspects of Internet learning have been researched, the affective aspects of Internet learning such as feelings of anxiety have not been

studied until now. Thus, the following definition and review of the literature will come from the body of work relating to the broader category of computer anxiety.

Computer anxiety is a fear of interacting with computers that is disproportionate to the actual danger of the situation. Computer anxiety leaves the user in an uncomfortable mental state in which he/she experiences debilitating physical and/or emotional symptoms.

The type of fear experienced by the computer user varies from one individual to another. For instance, a person might fear breaking the computer, losing important data or experiencing embarrassment in situations that he/she feels might arise from lack of computer mastery. After failing to adequately cope in an anxiety-provoking situation, the computer user may experience learned helplessness—a feeling of incompetence, inadequacy, and powerlessness. Learned helplessness can become a problem, since individuals who feel helpless will tend to avoid the anxiety inducer. Besides anxiety's relationship to avoidance behavior, computer anxiety is also related to poor performance. Anderson found that college students who failed a computer test had significantly higher levels of computer anxiety. Causality cannot be determined in this case, yet whether anxiety played a part in causing students to fail the test or failing the test increased students' computer anxiety, those students reporting anxiety cannot be allowed to slip away and drop out of the computer age.

The area of study known as computer anxiety, in several cases, including Todman and Monaghan's work has links to Albert Bandura's social cognitive theory, particularly with regard to students' self-efficacy. Self-efficacy is defined as a person's judgment about his or her ability to perform a task within a specific domain. The tie between low self-efficacy and anxiety makes

Bandura's concept significant to the study of computer and Internet anxiety. Students with low self-efficacy are more likely to: Attribute their failures to low ability; feel they are less in control of their environment; and avoid the activity in the future. Given the attributes of low self-efficacy, it comes as no surprise that anxiety is often inherent to it. Students who judge their ability to perform a task as being low tend to, "experience stress, anxiety and depression when goals have not been met". Thus, when studying students' computer or Internet anxiety, it is important to look at instructional techniques and behaviors that either lower or raise students' self-efficacy so that instructors can learn what to avoid and focus on effective strategies to employ.

As the Internet has grown so has the need for effective approaches toward curriculum and instruction pertaining to the Internet. Often articles present models for teaching and effective instructional techniques; however, they do not so often address Internet anxiety specifically. The following are some instructional approaches that have been used in Internet classes: teaching students about both the hardware and software components of the system and information skills simultaneously providing hands-on experience; giving one-on-one assistance; attempting to make the students' first experience a successful one; asking students what they expect out of the class; encouraging students to share "questions, problems and triumphs" with the whole class; using step by step work sheets as a supplement to verbal lectures; and encouraging peers to **help one another**.

Several researchers have proposed instructional strategies that are intended to take the "byte" out of computer anxiety. For some of these strategies, there is a high degree of agreement among professionals, while the

verdict on other strategies remains elusive. The following are just a few examples of some of the most talked about ways to reduce anxiety or stop it before it ever starts.

An antithetical relationship exists between playfulness and computer anxiety. It is thought that play might be of particular benefit for people who are in what is called the inquiry frame which is the self-directed stage people enter when they become focused on expanding and deepening their computing-knowledge. Others however, have found play to be beneficial in the beginning stages of learning. Pina and Harris, who focused on anxiety-reducing and confidence building teaching strategies to be used in computer literacy courses with preserviced teachers, cited play, such as allowing students to press any button on the computer, as one of their main strategies.

Learning through verbal lectures and learning by doing are certainly not synonymous experiences and should not be misconstrued as such by instructors. For instance, a student listening to a lecture about a process on the computer may not be able to translate those words into actions which could cause a fair amount of anxiety for the student-hence, the need for hands-on practice. Several researchers studying computer anxiety have documented the benefits of hands-on experience. Castleman and Pina and Harris promoted the hands-on approach in a nonthreatening environment as well as Hunt and Bohlin who also advocated providing demonstrations and ample hands-on time under the supervision of "tirelessly patient" instructors so that students can sharpen their skills.

Much of the literature in the area of computer anxiety focuses on unpressured instruction that increases self-efficacy and beliefs about the controllability of the situation. The notion of self-efficacy stems from

Bandura's social cognitive theory, while the idea of locus of control comes out of attributional theory. Self-efficacy is defined as an individual's judgment of his or her ability to perform a specific task. Thus, a person with high computer self-efficacy would have confidence in his/her ability to master it. Locus of control, on the other hand, refers to a person's belief about the controllability of a situation. Those who view a situation as out of their control are frequently subject to anxiety and avoidance whereas those who believe they are in control tend to be more persistent and put forth more effort. In a qualitative study, Todman and Monaghan concluded that regardless of age, a relaxed, unpressured introduction to computers, in which the individual is encouraged to feel competent and in control, tends to result in a lower level of computer anxiety and a greater tendency to use computers subsequently as a student.

They define a relaxed environment as one in which stringent requirements and evaluation methods are avoided and methods to improve self-efficacy and controllability beliefs are sought.

The verdict is still not in with regard to self-regulated learning as a method for reducing computer anxiety. Pina and Harris advocated self-regulated learning and said it met with much success in their classrooms. However, in a different study that ran counter to the authors' expectations, it was found that a group of university students who received computer training through direct teaching exhibited less anxiety at the conclusion of the study than a group who received training through a combination of direct teaching and collaborative self-learning. The direct instructional model was considered a traditional model that included the presentation of new material practice and review, where as self regulated learning was thought to be consistent with a constructivist philosophy and a

social cognitive perspective that emphasized students' employing appropriate strategies to achieve challenging goals which they have set for themselves thereby increasing self-efficacy. The researchers, in this case, utilized a quasi experimental design together with qualitative methods such as interviews, adding depth to the study. Because of the relatively small sample size (group 1, $n = 16$, group 2, $n = 15$), caution should be exercised with regard to the generalisability of these results. Thus, it seems that more research needs to be done in this area to clarify the outcome.

It has been shown that because of the widespread and still growing use of the Internet, it is necessary to provide an Internet education to as many people as possible, in the best way possible, so that they will have the motivation to seek new computer knowledge and experiences in the future. Part of providing this education in the best way possible is to acknowledge and attempt to alleviate computer anxiety in the classroom. Several of the instructional strategies used to deal with computer anxiety that have come out of the research were discussed in this review. Although many of the strategies that are meant to reduce computer anxiety may be applicable to Internet anxiety, there is still a point where the two types of anxiety diverge. The one-of-a-kind virtual world of the Internet is a place without boundaries and a space without a core that will cause users to experience different kinds of emotions, some of which will be more negative than positive. For this reason, it will be important in the future to address a more specific form of computer-anxiety-Internet anxiety.

In order to provide a vivid description of a particular site regarding a nascent concept-Internet anxiety--the decision to use qualitative research methods, supported by observational data, interviews and

documents, was made. Qualitative research or field research beneficial and often used for detailed analysis of small group situations.

In order to maintain confidentiality, all names presented in this study have been changed. The subjects in this study were adult students in an Internet class designed for beginners at a suburban, midwestern community college. At the start of the class, there were twenty-one subjects where as by the end there were seventeen.

The purpose of the class was to have students acquire basic skills (i.e., using search engines, learning HTML format) and general theoretical knowledge about the Internet. Each individual's purpose for taking the class varied. Some individual reasons for choosing the course included: fulfilling college requirements; learning how to create a Web page; enhancing Internet/computer skills for career; and learning the Net for fun. Generally, the students in the class varied in age, ethnicity, race, socioeconomic status, and educational background; the class included four- and two-year college students, retired students, and students who were already well into their careers. The majority of the class was white; however, two Chinese women, a Middle Eastern male and an African-American male added diversity to the class. There were close to an equal number of men and women. As far as computer background, all had some limited experience with computers and the Internet; although, some had much more computer experience than others. For instance, one young man used a personal computer everyday at his job. He stated, "I use Microsoft word and programs such as Excel regularly." Other students, however, had no regular access to computers and little experience with the Internet.

Several methods of data collection were employed to

achieve triangulation: Observation, semi-structured interviews, unstructured interviews, and documents (syllabus, class handouts). The methods were used to identify instructor techniques and behaviors that were either alleviating or exacerbating the students' Internet anxiety. While observing the class and conducting interviews, the focus was signs of anxiety such as cues of nonverbal frustration and fear; cues of verbal frustration and fear; and cues of learned helplessness along with avoidance behavior.

Miles and Huberman's three-part interactive model of data analysis was followed for this study. The first phase, called data reduction, includes choosing, focusing, consolidating, abstracting, transforming, and coding data gathered from observations and interviews. Part two involves a data display which is concise, organized information such as in a graph or a chart. In essence, it is a summarizing image of the data. Lastly, part three entails drawing conclusions and verification. It is at this phase that the triangulation of data is emphasized. Overall, Miles and Huberman's model is complete, detailed and well suited for the purposes of this study.

From the data collected in the field, four areas of Internet anxiety were identified as well as several categories of instructional techniques and behaviors that either reduce or intensify anxiety.

Four areas of internet anxiety

HTML (Hypertext Markup Language), SLIP (Serial Line Internet Protocol) connections and URLs (Uniform Resource Location) are just a few of the lexicons of the Internet/computer world that are part of learning in a beginners Internet class. A majority of students in this class had feelings of anxiety as they were introduced to a host of new vocabulary words and acronyms. A black male in his thirties explained that it was like, "learning a

new language where you only understand pieces of information."

Net search anxiety

Arriving at the intended location on the Internet is not an easy task. There are often problems in limiting and narrowing searches, problems with documents that have been closed or never existed in the first place, and various technical blocks to finding the desired site. An older white male commented that, "The Internet is like a maze-you can't look over the top--you have to keep backtracking all the time. Sure it's very frustrating for some people." Several members in the class accepted the uncertainty of searches as a fact of life while others experienced moderate to extreme anxiety. During an interview, Diane, a thirtyish white female majoring in criminal justice, explained that, when she "gets stuck" and is not able to find the information she is looking for it, "eats me up," She said, "It sometimes gets to a point where I just don't want to go to class, I think I'm not going to make it through the day." In another interview, Newman, a young white electronic media major with a fair amount of computer experience stated that he felt extremely, "frustrated and betrayed" when he is not able to find the topic he's searching for on the Net which is often. He added that it frequently causes him to avoid the Internet for a certain period of time.

Internet time delay anxiety

At this time, technology has not caught up with the demand of the millions of people who want to go online. The Internet is clogged with more and more people causing more and more busy signals and time delays. The "anger" and "frustration" several students felt, especially under time pressures in their own lives and homework due dates, was apparent in this class.

General fear of internet failure

A few students in the class expressed a diffuse fear of Internet failure. This was a generalized anxiety that they would not be able to negotiate the Internet, not be able to learn the content of the course, fail to complete the homework assignments and fail the tests. Jane, a young female education major with little computer experience and a dislike for technology, on her first day of class, repeatedly lamented, "Oh my God, I'm gonna fail this class." She dropped the class after a few weeks.

The low self-efficacy connection

Low self-efficacy was the thread that ran through each of the four areas of Internet anxiety. A student who has low self-efficacy, as mentioned previously, judges his/her ability to perform a task as being low, feels less in control, and believes the low ability is internal. For each of the four areas of anxiety, there were examples of students in class blaming themselves for failing to perform. For instance, Diane exclaimed, "I think it's me. I think it's me. I think I'm not capable of getting where I want to get and when my friend Dana wasn't here today I felt lost... I got this panic feeling like, oh my God, he's gonna give us an assignment and I'm not gonna get to it in time." Even with Internet time delay anxiety which is basically a problem with the technology, Newman, felt it was his fault when he was stopped because of time delays. He explained that he felt, "stupid" and thought it must be his fault that he couldn't get to the information he wanted. In another instance, Diane's friend Dana, who did not seem to experience much anxiety in the class, was not exempt from blaming herself for not being good at book learning (as opposed to hands-on learning with the computer) even though most of the class seemed puzzled after a lecture imbued with a barrage of cryptic text. From these examples and others, it was clear that, in

this class, low self-efficacy played a significant part in Internet anxiety.

Instructional techniques and behaviours

The following section is a list of instructional techniques and behaviors, some of which mitigated the students' Internet anxiety in this particular class and some of which exacerbated the students' fears. All of the instructors' tactics related to one or more of the four areas of anxiety identified, in that he either addressed the concerns in these defined areas or failed to alleviate the students' anxieties as they related to the four categories of anxiety, including Internet terminology anxiety, Internet search anxiety, Internet time delay anxiety, and general fear of Internet failure. Additionally, many of the successful tactics used by the instructor addressed low self-efficacy concerns either directly or indirectly.

The instructor emphasized the Internet as a "live Internet" which counteracted some of the false promises that people like Newman felt they had been bombarded with. The analogy of the Internet being like a living organism highlights the fact that it is not perfect, i.e., sites come and go so people may not be able to find what they are looking for. The instructor also warned students about time delays several times which Newman said helped him to be less anxious because he knew it wasn't he who was doing something, "wrong or stupid." The instructor devoted class time to a brainstorming session about the pros and cons of the Net.

Narrowing choices and searching out alternative sites were some of the most anxiety provoking situations for this class. A young man stated, "The most frustrating aspect of the Net involves obtaining the information that I am looking for. If I want to find information about caring for houseplants and use a search engine, I could get information about anything from flower shops to

power plants." He went on to say, "the professor told the means for narrowing searches on particular search engines... the professor has been very helpful with correcting information or suggesting alternative sites if something could not be accessed." The instructor also acknowledged the importance of helping students to search and narrow choices to reduce their anxiety. He stated, "they don't always get where they want to go and they find it frustrating... I try to provide examples and a variety of items to search for requiring different methods."

The instructor provided from a half hour to an hour and forty minutes of class time (out of a class that lasted for 2 hours and 40 minutes) for supervised practicum. Many times he stayed after class as students continued to work on their homework assignments. This was especially important for students who otherwise did not have access to the Internet and worried that they would not be able to finish their homework.

The instructor welcomed questions and addressed concerns at any point during lectures, by calling on people right away and giving detailed answers. Moreover, he recognized and acknowledged the students' anxiety with statements such as: "People are probably nervous about the paper because it has to be in HTML. Don't let that stress you. Just do it like a regular paper. It's not that hard to transfer"; "I'm going to give you time to work on your papers now since I know that's your major stress point... the latest stress point"; and "Your midterm results aren't that bad and you have time to recover." The instructor allowed peers to help each other, which they did continuously, during class and practicums. Diane stated, "It's good to find people suffering with you, 'cause sometimes you think it can't only be you."

During class, the instructor allowed students' to follow their curiosities and see where it led them on the Net. It seemed to help Jane who did something personally useful for herself by doing a search in the real estate section; although, she did diminish her accomplishment by saying, "Oh, I was just playin'."

Students who had problems with homework assignments were able to turn them in late for credit. Additionally, if it seemed he constructed a test question poorly, the instructor was willing to throw it out. In general, the leeway was built into the course.

Consistently, the instructor projected an easygoing manner and did not display anxious behavior. He modeled calmness by his even tone of voice, relaxed posture, smiles, and humor-even in the face of problems on the Internet such as difficulty accessing particular sites.

The midterm Jane said, "I'm so worried about this test, I don't know what he wants. I don't know if we're actually going to have to do stuff on the computer or write, ya know?" A few seconds later, the instructor passed out a practice test that addressed Jane's concerns. He then went over each specific question to come. A week after the midterm, the instructor passed out a status sheet with each person's point totals, allowing each to determine how many points he/she would need to earn in order to achieve the desired grade. It was the general practice of the instructor to discuss concerns regarding evaluation procedures throughout each class.

During the second class session, the instructor used an abundance of acronyms and new vocabulary words including Web server, JAVA, SHTTP, case sensitive, file path, VAX, FTP, HTTP, HFTP, IP Packets, Telnet connection, domain, and host just to name a few. Some of these words he defined, some he did not. The instructor

also passed out several handouts with most of the words undefined. One-by-one the students seemed to drop out of the lecture as they were being presented with loads indiscernible text in a short time span. The students rolled their eyes, shrugged their shoulders, and eventually put down their pencils and began tinkering with the computers. This was even more of a problem for two Chinese students who soon after dropped the class.

In this class it seemed that the students who had more anxiety tended to want direct learning from the instructor, where as those who had little anxiety were comfortable with the fact that this class focused on collaborative, self-regulated learning. For instance, Diane who experienced high anxiety in this class explained that she preferred her last computer class to this one and felt less "panicky" because the instructor led the entire group through problems and processes: "Whatever he had on his computer [her last instructor] he would bring up on all of our screens in the classroom.

Conventional University Courses

Information technology is sometimes perceived as a major threat to higher education because it could endanger the interpersonal contexts which give learning meaning and utility. However, in the UK, in common with a number of other European countries, the last decade has seen a rapid expansion in access to university level education with diminishing funding per student. Under-funded expansion prejudices the viability of traditional modes of teaching and learning. Against this background, information. The value of students' active participation in discussion of their courses, in questioning, testing their understanding and debating differing interpretations, has long been recognised in higher education. In many disciplines in the UK, small group tutorial meetings have traditionally offered the main way of providing for such interaction, but rising student numbers and declining resources have resulted in fewer tutorial meetings and/or meetings with larger and larger numbers of students per group.

Traditional tutorial teaching is thus under threat and computer mediated communication affords a possible means of providing for greater interaction between tutors and students, and between students themselves. The term 'skywriting' was introduced by Harnad to refer to the use of multiple reciprocal e-mail in the service of academic discussion. Harnad argues that electronic mail retains the advantages of the written form

of language while offering speed and the possibility of addressing any number of recipients simultaneously. It also offers a form of response which has the potential to support highly focused conversational interaction. Moreover, insofar as there is an 'audience' of others to whom the discussion is accessible, the interaction can come to resemble a symposium or discussion.

Skywriting has been built into a number of undergraduate courses in psychology at the University of Southampton, and has taken different forms with different courses. This paper examines experiences from a first and a second year with over one hundred students each) and a small third year seminar course with six students, all supported by skywriting for the first time in the academic year 1995/6. Messages were sent by e-mail to a list which included the tutor(s) concerned and all the students on that course, with all replies also going to the list. To supplement this, the tutor extracted all the messages from the list at regular intervals and placed them in a Hypermail archive on the World Wide Web. Here the reader could sort them by author, by date or by thread.

A variety of research methods, including questionnaires, observations, semi-structured interviews and group discussions have been used to try to understand how this innovation is perceived and received, and how it comes to function within its setting.

At least three quarters of the students enter the psychology degree programme at the age of eighteen, and three quarters of these are female. The remainder comprise mature students (typically in their thirties) and non-UK students. Attitudes towards, and experience with computers in various applications are assessed at entry using the ITIE Questionnaire. All students had at least a little previous experience of computer use, either at

school, at home or at work. Almost all had experience of using computers for both word processing and games, but experience in other areas of computer use was variable. About 20% reported at least some experience of using computers to send or receive messages. Of 80 first year students on the large lecture course, questionnaire responses from 57 Psychology Honours students were obtained. An aggregate measure of experience showed that male students had significantly greater experience with computers than females, ($t = 2.13$, $df = 55$, $p < 0.05$), but nearly all students expressed broadly positive attitudes towards computers.

The participation by 56 of these students was monitored during one complete set of face-to-face tutorials, recording the frequency of unsolicited contributions by each student. Scores ranged from zero to 21 contributions in the 40-minute tutorial. The male students contributed on average more than twice as often as the female students ($t = 3.54$, $df = 54$, $p < 0.001$).

The relationships between frequencies of face-to-face tutorial contributions and contributions to the skywriting archive were examined. Interestingly, there was no correlation between the frequencies of contributions in the two media ($r = -0.02$; ns.). Neither attitude to computers nor experience with computers as assessed at the start of the first year predicted the students' involvement in skywriting, indeed both correlations were close to zero. In contrast to face-to-face tutorial contributions, the frequency of skywriting contributions was as high amongst the female students as amongst the males. An analysis of contributions as a function of gender and medium (i.e. skywriting versus face-to-face tutorials) using analysis of variance yielded a significant gender-by-medium interaction ($F = 8.54$, $df = 1, 55$, $p < 0.005$) reflecting relatively much higher levels of female contribution to skywriting than in face-to-face tutorial

interaction. The mature students contributed more than the younger students in skywriting as well as in face-to-face tutorial interaction.

The Revised Approaches to Study Inventory was administered to 24 students, 12 of whom had participated in the skywriting and 12 who had not. Those who participated actively scored significantly higher on the 'Deep Approach to Study' subscale ($U = 27$; $z = 2.6$; $p < 0.01$), and within this they score significantly more highly on 'Intention to Understand' ($U = 25$; $z = 2.7$; $p < 0.01$) and 'Use of Evidence' ($U = 38$; $z = 2.0$; $p < 0.05$). The nonparticipants scored significantly higher on the 'Surface Approach to Study' subscale ($U = 27$; $z = 2.6$; $p < 0.01$), and within this they scored significantly higher on 'Passive Learning' ($U = 23$; $z = 2.9$; $p < 0.01$) and 'Fear of Failure' ($U = 38$; $z = 2.0$; $p < 0.05$). None of the Approaches to Study measures were significantly associated with frequency of contribution in face-to-face tutorials.

Course assessment outcomes (based on essay, unseen examination and practical class marks) were available for the 56 students for whom there was participation data for both skywriting and face-to-face tutorials. Frequency of contribution to skywriting showed a modest positive correlation with course assessment outcomes ($r = +0.32$, $n = 56$, $p < 0.05$). Frequency of contribution to face-to-face tutorials showed no significant relationship to assessment outcomes overall ($r = +0.13$), though underlying this was a clear relationship to assessment outcomes amongst the males ($r = +0.60$, $n = 12$, $p < 0.05$) but no relationship at all for females ($r = +0.01$). This differential pattern of association further underlines the significantly different patterns of response to face-to-face tutorials amongst the male and female students.

At the half way point in the course when skywriting contributions were assessed, just under a third of the students had contributed no messages, a similar proportion had only contributed once, and some 40% had contributed more than once. Student messages were typically short (about 100 words) and addressed to the course lecturer. All contained questions, while only about half contained any expression of opinion. Most of the topics related to issues raised in the lectures. Tutor replies tended to be longer because they typically used a quote/comment format to respond to particular aspects of the student's question.

Semi-structured interviews were conducted with eight students who had not contributed messages to skywriting, and with 11 students who had contributed. All interviews were transcribed, and recurrent themes were identified. Light & Light (in press) give a fuller analysis of this material than space allows for here.

Asked why few student messages generated any response from fellow students, despite the tutor's efforts to encourage this, a typical comment was: "I wouldn't like to criticise anyone else's work really, especially as you end up with your name next to it".

Skywriting was seen as having particular benefits for those students who found it difficult to contribute in face-to-face tutorials: "People who can't speak up during tutorials have much more opportunity on skywriting—you can take as long as you want". One such student said: "You can think of something three hours later and say 'I wish I had said that in the tutorial' and you can't do anything about it because its gone, whereas in skywriting you can think have just thought of something else' and send it and still be incorporated at the end of the day".

In skywriting, students felt that they could really work out what they wanted to say: "Often when somebody says something to you and you reply, you say something before you've really thought out what you're going to say to them, but when you're arguing with someone over the computer, you can really make sure your message is clear".

What put many students off, on the other hand, was that everybody was going to be able to see their message: "It frightens me, the fact that what I'm saying is going to go back to everybody in my year", and: "The thought of trying to express an opinion on something that you don't know much about anyway can be a bit daunting when the whole world can see you making a real wally [fool] of yourself". Many of the students were concerned that the tutor's response might shame them in public: "I think ordinary people have been put off by harsh replies".

For these reasons, skywriting messages tended to be almost obsessively well prepared, spell checked, and were often even read over by friends before being sent: "Before people write on the skywriting they really research their stuff and they have a query and they polish their query so that it looks sensible and it sounds right, whereas in a tutorial you just kind of come out with stuff".

One of the main benefits perceived by these first year students was being able to read their fellow students' questions. This enabled them to 'find out what level everyone else is on'. The other advantage they saw was that other students tended to ask questions in much the same way that they would, so that they got a study aid at their own level. There are indications here that a kind of 'vicarious learning' through accessing the tutorial dialogues of other students with the tutor might be pedagogically effective.

Second year course

In the second year lecture course things developed differently. Levels of participation were lower, probably because the course lecturer (who saw the purpose of skywriting mainly in terms of discussion of ideas) did not encourage students to write directly to him and did not reply directly to student contributions in the same way that the first year lecturer did. What emerged was aptly described by one student as: "A discussion between a select group who are computer-proficient, wide reading students".

Gender emerged as a very explicit issue, with almost all contributions coming from male students. Reports from the course tutor indicated that no such gender bias was evident in the discussions during face-to-face tutorials. To the male 'skywriters' it seemed that the sender bias in contributions was caused by the female students' undue reserve: "It's a bit surprising the fact that women don't use it. Women tend to say 'Oh dry, cold, grey technology'. They tend to sit there and be quieter more often than men do, particularly the younger ones, so they might just want to sit there and watch what is going on rather than say anything".

To the nonparticipating female students, on the other hand, skywriting seemed to be a medium suited to computer nerds: "There are some people who just adore sitting down and skywriting"; "There is a little society of people that love computers"; "They are out to prove what they can do".

For the third year students, working in a group of six in a specialist area they had selected for themselves, the experience was different again. All participated, with an average of 11 messages each. Most messages took the form of commentaries on papers they had read, averaging about 500 words each. Although the students

rarely responded (at least in this medium) to one another's messages, they saw the messages as being directed at least as much at one another as at the tutor.

For them, it was very largely a way of sharing the work: "We were being asked to comment on various seminars and discuss various issues that had been brought up there. We didn't do all the readings. One person would do one of the readings and then distribute it to everybody else via the skywriting"; "We took it in turns to do the major comments, so you were acting as a teacher for the others"; "We had an ordinary tutorial every week and then skywriting backed it up and acted as a preparation for the tutorials. The tutorials were really traditional tutorials well prepared for".

The impact of computer mediated communication in higher education has been seen in both conservative and radical terms. Henri, for example, says of student 'teleconferencing' that: "It is exactly as in traditional learning situations: the student speaks; the teacher answers, confirms, approves, reinforces". In contrast, Riel sees computer mediated communication leading to a reconstruction of the teaching/ learning relationship, shifting the role of the teacher from controlling the transmission of information to providing intellectual leadership in 'challenging conversations among a community of learners'.

Observations in these studies with the first year course essentially endorse Henri's position. Skywriting seems to provide a new and useful channel for student-staff communication without any concomitant change in the underlying pattern of teaching/ learning relationships. Used in this mode with these students, however, the new medium did dramatically redress the gender imbalance which characterised face-to-face tutorial interaction, and rendered students' relative levels

of attainment more visible' to one another. On the second year course, skywriting came to function rather more in the way that Riel envisaged, as a conversation amongst a community of learners. However, the 'community' in question was a small and unrepresentative one. Some of those who did engage with the debate clearly did see skywriting as having the potential to transform education: "The advantages are kind of enormous - it's an opportunity for people to discuss things at all levels - to get all sorts of replies - it enables all sorts of experience to be put into the knowledge pool. People are a huge resource of knowledge so it means it's not so focused on the actual lecturer or tutor, so you have got a much bigger pool of experience and information".

On the third year course, the students found the technology valuable in a more prosaic way, as a good way of sharing work and information. They didn't comment 'in print' on one another's contributions, but they found the use of skywriting for 'shared-commentaries' helpful and nonthreatening, and an excellent preparation for the face-to-face sessions. They felt that the small group size and the fact that they all knew one another personally contributed significantly to the fact that they were able to use the medium so extensively and cooperatively.

It is not possible to say with confidence how far the differences which were observed were a function of the fact that students were at different stages of their degree programme. Skywriting was new to all but second year students, and it is equally unclear on present evidence how far increasing experience with the medium across successive courses will impact on usage.

None of the students who were interviewed in any of the three years would willingly have sacrificed face-to-face sessions in favour of skywriting. Given the

pressure on teaching resources, and the substantial tutor time absorbed by at least the 'first year version' of skywriting, it may be unrealistic to envisage any widespread adoption of skywriting without cost to other forms of student-tutor contact. However, if student-tutor question and answer dialogues are really useful and usable for other students, then across years a considerable resource could be built up with modest effort, which could evolve with the course. Instead of replying at length, the tutor could simply point the way with a link.

The three cases examined suggest that broad generalisations about the impact of this type of technology on education are unlikely to be sustainable. The form which even a single type of computer mediated communication such as skywriting takes is likely to depend on the size of the group involved, the shared knowledge and mutual familiarity of the students, and the stance taken by the tutor.

In broader terms, it is likely to depend less on cognitive or technological considerations than on what those concerned feel comfortable with. Patterns of use of the technology and any learning benefits that may result from these will be conditioned at least as much by considerations of social comparison and self presentation on the part of the students as by either their attitudes to technology or their cognitive attributes.

What is needed is a fuller understanding of the 'ecology' of student learning. Universities are complex 'ecological niches' of course.

Different disciplinary contents and contexts will make a difference, as will different national educational traditions. But the experience of being a 'student' in a full time university setting has some widely shared features,

and a better appreciation of these common features would highlight the way to use computer mediated communication to good effect. Meanwhile, these observations indicate that computer mediated communication is as relevant to full time residential higher education as it has been found to be for distance learning, and that there can be real benefits in 'reaching for the sky'.

Computer Workstation Design on Student Posture

The growth of classroom computer use necessitates consideration of ergonomic design issues that can support new modes of learning without causing any of the negative health effects associated with the use of computers.

Literature on technology integration typically has focused on teacher training, networking computers, technological support, and facility improvements.

The most recent congressional study investigating school facilities addressed facility improvements in terms of acquiring computer hardware and software and preparing the building structure for the installation of this new equipment by increasing electrical capacities and providing conduits for cabling. Issues relating to the modification of interior elements, such as ergonomic furniture were not addressed. Hedge, McCrobie, Land, Morimoto, and Rodriguez found that a keyboard and mouse placed on a standard desktop promote unhealthy posture, discomfort, lost productivity, and risk of musculoskeletal' injury in adult office workers. Furthermore, this research indicates that a keyboard and mouse arrangement adjusted to fit the anthropometric data of an individual can significantly reduce the risk of musculoskeletal injury, and have positive effects on worker performance. These findings are likely to apply to

children as well. If so, it is of particular concern that schools consider ergonomic design issues in their computer classrooms.

The design of classroom furniture typically reflects concerns of maintenance issues and flexibility in modes of student-instructor interaction, rather than the health and performance of the student. Some researchers have investigated the design of educational furniture with the goal of improving children's seated posture. Floyd and Ward assert that "[postural] habits... once formed, are tenaciously held". Because half of a child's day is spent at school, the educational system plays a large role in supporting healthy postural habits. Classroom furniture was not designed based on the anthropometric dimensions of the intended user. This meant that children of various ages, shapes, and sizes were forced to use the same furniture. It was not until after World War II that manufacturers of school furniture made the decision to design moveable tables and chairs that could better accommodate variations in physical growth and development in children.

Two surveys conducted in Australia looked at the adequacy of furniture used in educational settings based on anthropometric requirements. Taken together, the surveys included infants; students at the primary, secondary, and tertiary levels; and adult user groups. No one size desk or chair was found to be appropriate for all students in a particular grade level. Each class included a range of body shapes and sizes that need to be accommodated by the furniture. Although these anthropometric surveys were done in Australia, they point to the need to consider individual differences when designing educational furniture.

Researchers have investigated the fit between school workstation design and student comfort and posture

Aagaard-Hansen and Storr-Paulsen note that 7 to 11 year-old children preferred an ergonomically designed workstation to the traditional workstation when doing written work.

The traditional station consisted of a flat tabletop while the ergonomic station had a 0° to 20° tiltable table and a chair with a waterfall-front seat, Marschall, Harrington, and Steele compared the effects on the posture of 5-year-old children when working at a traditional school workstation and an ergonomically designed workstation.

The traditional workstation was a 52-cm-high flat surface and included a 33-cm fixed-seat-height wooden chair. The ergonomic workstation had a 15° sloping work surface and chair with an adjustable knee support and a back rest. Posture improved and less stress was placed on the child's musculoskeletal system when working at the ergonomic desk. Although neither of these studies included computer workstations, the findings support the present study in that they both addressed the issue of educational furniture design and the need for "fit" between the student and the physical environment.

Mandal reported that "during the past 20 to 30 years, the average height of school children has increased by four to five centimeters. Because the replacement of classroom furniture occurs so infrequently, many students are presently working in environments that were designed using the physical dimensions of children of smaller stature. Furthermore, work surfaces in today's educational environments are no longer used just for reading and writing. Lane and Richardson point to a failure on the part of both furniture manufacturers and school administrators to address the issue of the design of school furniture for computer use. The use of computers for various classroom tasks places new

demands on the educational setting. The relationship between children and the modern classroom environment is more complex; part of this complexity manifests itself in the risk of musculoskeletal injuries associated with computer use.

Musculoskeletal problems are the foremost health concern associated with computer use. Maintaining healthy posture is essential in avoiding musculoskeletal strain during computer work. There are several criteria to consider when assessing seated posture: back support, leg support, neck angle, elbow flexion, arm abduction, and wrist angle. A basic principle in work design is to limit the number of body parts necessary to accomplish the task. The more body parts a task requires, the greater the effort to execute. A poor workstation design causes unnecessary muscular strain and fatigue for users, thus reducing productivity.

The design of the computer workstation can facilitate or inhibit healthy posture. Two of the primary components of workstation design and their effects on posture are keyboard height and mouse pad position.

Keyboard height should be low enough to maintain a 90° angle between the upper arm and forearm. Stack found that a higher keyboard height, causes greater elbow flexion. This, unfortunately, is the arrangement typical in most schools. One study on workstation design and musculoskeletal discomfort found that arm discomfort increased as keyboard height increased above the elbow level. High levels of discomfort in the neck and shoulder area were also reported.

However, simply lowering the keyboard height does not remedy the problem; consider what happens when the keyboard height is lowered, but the work surface is still flat. The elbow is now at the suggested 90° angle, however, the adjustment also caused more severe wrist

extension--an undesirable effect. To compensate, the keyboard should be reoriented into a negative slope to reduce muscle load.

Mouse pad position

Atwood in a study of computer-assisted design and drafting operators found that pain or stiffness in the right arm and shoulder was typically related to extending the right arm to use the mouse, and back stiffness was generally related to leaning to the right to operate the mouse. In most instances, the tablet holding the mouse was located too far forward and to the right of the operator. As a general principle the arm that operates the mouse should be located in a resting position when the mouse is positioned in the corner of the mouse pad that is furthest from the body laterally, but closest longitudinally.

Musculoskeletal problems can be avoided with proper training and computer workstations that encourage healthy posture. Manufacturers have begun to recognize the special needs of computer users and are now designing products that incorporate adjustability in the keyboard and work surface height. However, the group most frequently addressed when assessing and designing computer workstations has been adults. This is especially true for studies addressing the effects of workstation design on comfort and performance. Children most often use standard writing tables for computer equipment rather than workstations developed specifically for computer use. It is reasonable to propose that if adult workers experience discomfort and lost productivity when using inadequate workstations, then students working in similar settings will also experience these symptoms. To date, the only literature on computer workstation design for children has been on postural effects; issues of comfort and performance have not been explored.

There are presently no comprehensive standards from which school administrators, educational facility managers, or product designers can base their decisions about the design of computer environments for children. Knirk and Wilson offer suggestions for the design of computer workstations for children. Neither of the recommendations, however, reflects the latest research addressing the relationship between wrist angles and carpal tunnel syndrome; that is, the benefits of the negative slope keyboard. In addition, Wilson's recommendations appear to be based on scaled-down versions of adult workstations, not on data collected specifically for children. The most relevant research in computer workstation design for children was conducted recently at Cornell University. The study looked at the ergonomic appropriateness of computer workstations in school facilities for children in Grades 3 through 5 in six New York and Michigan elementary schools. Using the Rapid Upper Limb Assessment (RULA) as a measuring tool, the study revealed that all six schools had computer-equipped classrooms in which students assumed postures associated with high risk for the development of musculoskeletal disorders. In each of the schools studied, the computer, monitor, keyboard, and mouse were placed on the desktop. The researchers observed an overall lack of workstation adjustability and children of various height, ages, and grades using equivalent workstations. Oates and colleagues propose that if children are encouraged to preserve healthy posture through training and proper furniture design, the number of work-related injuries seen later in life may be reduced.

Existing educational furniture standards are no longer adequate for today's educational environments. They fit neither the size of the children nor the tasks being performed. Second, there is strong evidence

pointing to the adverse affects of poor workstation design on the musculoskeletal system in adults. This is likely to be true for children as well. Overall, the literature provides a strong argument for reevaluating and improving the situations in which we ask children to work. As schools integrate new technologies into the classroom, the computer becomes a new element in the overall learning environment. Currently school administrators, facility managers, and product designers have little empirical research on which to base decisions relating to the design of these evolving classroom settings. The present study uses objective measures to evaluate the effects of a task-oriented and ergonomically appropriate keyboard and mouse arrangement on student overall seated posture.

Based on research with adults, it is hypothesized that a student's performance and overall seated posture will improve with a keyboard and mouse arrangement adjusted to fit the anthropometric needs of that student. The workstation intervention has been operationalised as a tiltdown keyboard system (PT system). Research by Hedge, McCrobie, *et al.*, showed positive effects of the PT system on posture, health, and comfort for office workers. Although the system was not specifically designed for children, it has sufficient adjustability to accommodate a wide range of users. Thus, it is reasonable to expect positive results for children as well.

Fifty-eight students participated in the study: 30 sixth graders and 28 eighth graders. Participation was voluntary. These two grade levels were chosen because children in this range are using all aspects of computer hardware, and they have not yet achieved their adult statute. In addition, computer work was an integral part of the curricula for all of the students in these grades at the participating school.

The study was an experimental design in which the workstation configuration variable was manipulated under carefully controlled conditions. Each subject acted as his or her own control. Subjects performed two computer tasks under two conditions. In Condition A, students worked at a station at which the computer, keyboard, and mouse were placed on a standard desktop. This was intended to mimic the physical setup typically found in schools. The work surface height was adjusted to match that of the tables used in the computer lab on site. Under Condition B, subjects worked at the PT system, which allowed the keyboard and mouse arrangement to be adjusted to fit the specific anthropometric needs of the user.

The tasks performed included a keyboarding task and a mousing task. The keyboarding tasks involved typing one paragraph for five minutes. Two different paragraphs were 'used. Both were comparable in word count and syllabic intensity'. The mousing tasks involved tracing simple geometric shapes on the computer screen. The order of conditions and tasks within each condition were controlled for sequencing effects.

The experimental apparatus was set up in a small office not used by the school. It consisted of an individual student workstation featuring a PT system attached to a table with adjustable legs. The PT system incorporates a negative-slope keyboard tray that pulls out from under the desk. The negative slope affects the angle of the wrist. The tray can be adjusted to different heights depending on the size of the user. The ideal keyboard position allows the upper arm to rest directly by the side of the body and creates an angle of 90° or less at the elbow. The PT system also features a mouse pad that pulls out from underneath the desk. The PT system was chosen for this study based on prior research indicating beneficial effects on posture and comfort in adult office

workers. The same workstation was used for both experimental conditions. For Condition A, the PT system was tucked under the table, thereby serving as a standard worksurface. For Condition B, the keyboard tray and mouse pad were pulled out and adjusted to the individual. The chair, borrowed from the school, was a standard chair used for the sixth and eighth grades and was not adjustable. Previous research has pointed to keyboard height as the most important factor associated with computer work-related injuries. By isolating one variable, the impact of this variable can be assessed without the possibility of confounding.

The experimental procedure consisted of an introduction, the collection of anthropometric data, a short interview, performance of computer tasks in Conditions A and B, and a debriefing session during which questions were asked about which configuration they would rather use, workstation comfort, and ease of use. When stating their preferences, students were given five options:

- (1) desktop for both keyboarding and mousing,
- (2) PT system for both keyboarding and mousing,
- (3) desktop for keyboarding and PT system for mousing,
- (4) desktop for mousing and PT system for keyboarding, and
- (5) no preference.

Adjustments to the keyboard and mouse arrangement were made by the researcher. Students were shown how the PT system adjusted, but were not given any instruction about how to sit 'correctly'. The idea was to capture how the subject naturally responded to each experimental condition. A one-minute practice session

was set aside for students to get used to the keyboard configuration of each condition.

RULA data were collected for keyboarding and mousing tasks in each experimental condition. RULA is a survey method developed under extensive psychometric procedures to investigate the exposure of individual workers to risk factors associated with work-related upper limb disorders. The measure is frequently used in ergonomic investigations of computer workstations. The measure uses diagrams of body postures to evaluate the exposure to risk factors for specific body parts. The overall RULA score is an aggregate of an individual's adopted posture, action of the muscles, and external loading experienced by the body'. A low RULA score is associated with healthy postures of the upper and lower arms, hands, wrists, neck, and trunk.

All of the RULA observations were conducted by the first author. Reliability was established by having a team of independent observers rate four of the subjects on the RULA measure using the videotaped session of each subject. The inter-rater reliability using Kendall's coefficient of concordance was statistically significant, Kendall's $W = 0.773$, $X^2 = 27.82$, $p = 0.000$. The median score of the team of independent observers was then correlated with the experimental observer's ratings yielding a statistically significant Pearson correlation, $r = 0.96$, $n = 4$, $p = 0.039$.

Use of the PT system had a positive effect on posture for all children in this study'. Analysis of each body part was performed separately to determine areas of greater or less improvement. There was significant improvement in overall RULA scores while keyboarding with the PT system, $t = 6.26$, $df = 57$, $p = .001$, and while mousing with the PT system, $t = 9.79$, $df = 57$, $p = .001$. Table 2 indicates the overall average RULA scores for

keyboarding and mousing and the average scores for each body part. Table 3 explains how to interpret RULA scores.

A lower RULA mean score indicates that, on average, the workstation promotes healthier postures. Note in Table 1 that the areas of greatest concern are the upper arm while mousing, the neck while keyboarding, and the wrists during keyboarding and mousing. The highest average of the RULA scores for a specific body part was for the upper arm while mousing. Although overall RULA scores improved after the PT system intervention, the scores still remained outside the acceptable range as defined by McAtamney and Corlett. There was no significant improvement in RULA scores for the neck while keyboarding. Ninety percent of the posture scores for the neck remained the same in both experimental conditions. A significant correlation was found between neck posture and typing skill for both the desktop arrangement, $r = .41$, $p = .002$, and for the PT system, $r = .38$, $p = .003$.

Wrist posture improved more often for keyboarding than for mousing. Seventy percent of the wrist scores improved from 1 to 3 points on the RULA during keyboarding, while half that many improved during mousing. The majority of the wrist scores, however, remained the same for both experimental conditions. An analysis of posture scores across grade level was conducted in this study based on the Oates *et al.*, findings that suggested a possible trend that the severity of posture scores increases as age decreases. A t-test for independent samples indicated significantly higher RULA scores among sixth graders for the arm and wrist regions while typing with the PT system, $t = -2.53$, $df = 55$, $p = .014$. There were no significant postural differences between the grades for the desktop arrangement.

In the debriefing session, students were asked at which workstation configuration they would rather work, at which station they were more comfortable, and at which they found it easier to work. Students had five options in which to state their preference. The highest percentage of students choose the option of the PT system for both keyboarding and mousing in all three categories. The option of desktop for keyboarding and PT system for mousing was the next most frequently chosen option followed by the desktop option for both keyboarding and mousing.

There is a general benefit to the student in terms of physical well-being. Students can also distinguish between workstation arrangements that relate to their comfort, ease of use, and relationship to the computing task. The major hypothesis of this study was that overall seated posture would improve with a keyboard arrangement designed to fit the anthropometric needs of a student. There was a significant improvement in overall seated posture for both keyboarding and mousing, although the extent of the improvement was much greater for mousing. Similar results have been found for both keyboarding and mousing with adult computer users.

The RULA instrument allows both overall posture and specific areas of the body that are of greatest concern to be assessed. Of particular concern in this study were the arms, wrists, neck, and trunk regions. Smith states that the primary factor associated with back pain in computer users is seated posture that puts undue loading on the spine, back muscles, or both because of improper positioning. Oates *et al.* observed that 30%-35% of the fourth- and fifth grade students in her study assumed "stumped" postures. All children in Oates study worked on computers in the traditional desktop arrangement.

Children in this study would show poor back and neck posture when working at traditional desktop arrangements. The mean RULA scores for the neck and trunk region for the keyboarding and mousing tasks were 3.0 and 3.1, respectively. These scores indicate a situation that is not acceptable. Use of the PT system indicated improved overall posture in the neck and trunk region. For mousing, results suggest that posture in the neck and trunk region improved when the mouse pad was positioned close to the side of the child's body. During mousing tasks, posture in the neck and trunk region improved by .7 points with the PT system. The principal observation was that students who leaned or slumped forward while using the mouse on the desktop, sat with their back against the chair while mousing with the PT system, thus providing support to the trunk and neck.

There was a small but significant improvement in trunk posture during keyboarding task (.2), but no significant difference in neck posture. In addition, 90% of the subjects' neck posture scores remained the same in both experimental conditions. Further analysis revealed that neck posture was significantly correlated with typing skill; the lower the posture score, the higher the level of typing skill, desktop: $r = .41$, $p = .002$, PT system: $r = .38$, $p = .003$. More experienced typists may have had better neck posture because they could complete the keyboarding task while looking straight ahead. Less experienced typists exhibited worse neck posture because they needed to look down at the keys while typing. The RULA checklist is designed to facilitate a quick postural assessment; it is not a precise method. Specific posture changes cannot be detected with RULA, only ranges of postures. Therefore, there may have been slight changes in neck posture that RULA was not able to pick up.

The key ergonomic factors influencing comfort and

strain while computing involves muscle strain in the arms. Smith notes that discomfort and fatigue can contribute to diminished worker performance and satisfaction. Oates *et al.*, found that the work surface heights in the elementary schools she studied were "without exception, much too high" Results of the present study reveal a similar situation for middle school students. RULA posture scores for the upper arm during keyboarding and mousing exercises at the desktop arrangement were found to be out of the acceptable range.

The upper arm position improved significantly with the PT system for both keyboarding (.85) and mousing (1.83). A significant improvement was expected for mousing because the position of the mouse pad is lower and much closer to the side of the user's body with the PT system than when on the desktop. A significant improvement was also expected for keyboarding because in adjusting the keyboard placement to fit the anthropometric needs of the student, the height of the keyboard tray was specifically adjusted to let the upper arm rest by the side and maintain a 90° angle at the elbow. Students who experienced arm abduction while keyboarding on the desktop usually found it relieved by the PT system. The degree of arm abduction decreased for almost all students but was not completely eliminated. The PT system improved the situation for students who experienced arm abduction during mousing, but the abduction was not totally relieved.

The PT system is effective at encouraging proper upper and lower-arm positions. Although the apparatus was specifically adjusted to create ideal arm posture, more importantly, students (1) assumed this posture without any instruction about how to use the system and (2) maintained this posture throughout the duration of

the tasks. The PT system, by its design alone, encouraged sustained healthy arm posture. Carpal tunnel syndrome is one of the leading health risks associated with computer use. It is caused by extra pressure exerted on the median nerve in the carpal tunnel, which can occur when users are forced into uncomfortable arm and hand postures. Hedge, McCrobie, and colleagues found wrist movements outside the neutral zone in subjects who were typing with a keyboard on the desktop. Results of the present study showed poor wrist posture for both keyboarding and mousing on the desktop. Wrist posture improved for the students with the PT system. Similar results were found for adult users.

The degree of improvement for wrist posture, however, was much greater for keyboarding (.88) than for mousing (.38). This suggests that the negative-slope keyboard tray is more successful at mitigating poor wrist posture for typing than the mouse pad is in mitigating poor wrist posture in mousing. Observations of the mousing activity suggest that wrist posture may be related to the shape of the mouse and how students hold it. For both keyboarding and mousing, although improvements were noted, the average wrist score remained outside of the acceptable range as defined by McAtamney and Corlett, indicating that further investigation is needed.

The present study provides some insight into which postures the PT system helped improve for children and those where more work is needed. The findings suggest that the PT system at least partly meets the anthropometric need of the students 11-15 years old. Based on debriefing interviews, students preferred a workstation that could be adjusted to fit their anthropometric needs. The largest percentage of students preferred the PT system over the desktop arrangement in

terms of ease of work, preference as a place to work, and comfort. However, over half of the sample preferred the PT system configuration for mousing.

Students commented that it was easier to "maneuver the mouse" or "reach the mouse" with the PT system. Those who did not prefer the PT system for keyboarding indicated that it was more difficult to see the keyboard. If students are not touch typists or are not very familiar with the keyboard, then placing the keyboard farther away may be uncomfortable and cause neck strain. Students who indicated a preference for the desktop system for both keyboarding and mousing usually said it was because the arrangement was familiar.

Adjustability be incorporated into the design of computer workstations for children. Results of the present study confirm that postural benefits are associated with adjustable computer workstations for children. However, there are additional implications of adjustability that need to be considered in the context of a school environment. First, if the routine of workstation adjustment is to be practiced in schools and a child is expected to adjust a workstation on his or her own, then it is important that adjustable features are convenient to use. Shute and Starr observed that much of the "adjustable furniture on the market requires hand tools, much effort, and several minutes, all of which may seriously disrupt ongoing work. The school at which the present study was conducted recently purchased new "adjustable" tables for their computer facilities; however, height adjustments can only be made using an Allen wrench. Such adjustments are unlikely to be made more than a couple of times a year and cannot quickly be adapted to the specific needs of each user.

The demands on product durability in a school environment are likely to be much higher than in a

traditional office situation. Office environments usually have one worker assigned to a workstation for an extended period of time. In a school setting, one computer workstation could have as many as eight different students in one day. Durability therefore must be addressed specifically for educational settings.

Whether adjustable features on computer furniture are used in a classroom may also depend on differences in classroom management practices. At present, there is no research that has investigated the level of knowledge about ergonomic issues among computer educators. However, teachers are identified as the primary vehicles of change. Many articles have documented the importance of teacher training in technology integration efforts. Further research needs to be conducted to

- (1) **assess the present knowledge of educators about ergonomic issues,**
- (2) **find out if training in healthy computer work habits has been incorporated into classroom instruction, and**
- (3) **investigate whether ergonomic training affects workstation adjustment patterns.**

Another issue to address when considering adjustability in workstations for children is that furniture is likely to be used in unpredictable ways. Care must be taken to prevent accidents that can occur as a result of unintended use. As Medd points out, "it takes little imagination to convert a table into a hospital bed, a fire engine, or a bus". Imagine what a creative young mind could make out of the PT system. This issue may be most critical for very young computer users.

The issues of durability, ease of use, and accident prevention are recurring themes in literature regarding school furniture. The challenge for product designers is

to incorporate adjustability into a safe, durable, and cost-efficient computer workstation for children. Computer workstation design can influence a child's physical well-being.

Most critically, results revealed that children do adopt 'at risk' postures when using computers. This behavior was evident while students were working at the desktop arrangement. This observation is particularly disturbing as similar arrangements are typical in most schools. However, results also revealed that some of this risk can be mitigated with a task-appropriate and ergonomically correct keyboard and mouse arrangement.

In an effort to prepare students for success in the 21st century, schools are beginning to integrate the use of information technologies across the academic curriculum. Recent U.S. legislation initiatives supporting education reform and technology include

- (1) the improving Americans Schools Act of 1994, which authorized \$200 million for technology education for 1995 and an additional \$200 million in education infrastructure improvement grants, and
- (2) the Goals 2000: Educate America Act, passed in 1994, which established an Office of Educational Technology in the Department of Education.

Goals 2000 requires states that wish to receive funding under the statute to develop a state improvement plan for elementary and secondary education. The near future will see children of all ages using computers on a relatively consistent basis in schools. UP to this point, much of the acquisition and installation of computer technology in schools has been haphazard. The process has been dictated by short-term need, controlled by budget constraints, and made without the direction and

guidance of an overall technology-integration plan. However, schools are now being encouraged to develop more organized and thoughtful approaches to technology integration. Administrators are developing comprehensive plans in hopes of maximizing the educational value of their investments in new technology.

The number of incidents of computer-related injuries has risen significantly in the past decade. Students who practice healthy computing postures now may be able to avoid the onset of computer-related injuries in the future. The present study points to the need to address computer workstation design in school technology-integration plans. Given that until recently, the effects of computer workstation design on student work have remained relatively unexplored, there are still many gaps to fill before arriving at definite conclusions about furniture design for today's technology-rich educational settings. It is apparent that we need to depart from the status quo of computer environments for children.

Academic Achievement of College Computer Science

Relatively little research has sought to determine the predictability of student performance in computer science programs beyond the introductory level. Among those that adopted this focus, Anyanwu found that high school performance, but not matriculation test scores, related significantly to academic success in college computer science programs. Shoemaker reported that student grade point average (GPA) in computer science programs could be reliably predicted by high school GPA and the College Board Mathematics Achievement Test. In addition, Sorge and Wark identified mathematical and verbal skills as affecting student persistence in computer science programs, whereas Campbell and McCabe indicated that successful completion of the first year of a computer science program is a useful indicator of persistence in the major. Moreover, certain investigations were also directed at determination of potential gender differences in the prediction of student performance in the computer science programs. The greater part of the research completed regarding academic achievement prediction in U.S. computer science programs has been directed at the predictability of performance in the introductory computer science courses. Though not empirically supported by the evidence, these entry-level courses have nonetheless long served as gateways for computer

science programs in many universities. However, few researchers have probed the long-term predictability of performance following experience in introductory computer science courses.

The primary purpose of the present study was to determine whether student academic achievement in college computer science programs in Taiwan could be predicted by factors reported to have been effective in many of the U.S. studies cited. This study focused primarily on the prediction of overall performance in computer science programs, rather than achievement within a single computer science course. Moreover, by examining the relationship between performance in beginning computer science courses and performance in complete computer science programs, the study was designed to verify a hypothesized relationship between performance in introductory computer science courses and overall performance in complete computer science programs. Interrogating possible gender differences with respect to predictors was also a principal research interest.

The term computer science core courses is defined as all the computer science courses required by computer science departments for computer science majors among all the universities participating in this study. The average score of computer science core courses is employed as the academic success measure. Introductory computer science courses are entry-level courses offered and required by computer science departments. Typically, these courses are referred to as "Introduction to Computer Science".

This study was conducted in Taiwan during the fall 1995 semester. The study was designed to answer the following research questions:

1. Are college entrance examination (CEE) scores related to performance in college computer science programs?
2. Is overall high school performance related to performance in computer science programs?
3. Is performance in introductory computer science courses related to overall performance in the computer science programs?
4. Can reliable models be developed to predict performance in introductory computer science courses and complete computer science programs? If so, can the equivalency of the two models be demonstrated?
5. Are there gender differences in performance predictors for computer science majors?

Universities that provide computer science programs were surveyed. Because no information regarding college performances was available for entering college freshmen, freshmen students were excluded from the study. Hence, the study population consisted of 1,169 college computer science majors, including sophomore, Junior, and senior students currently enrolled at the participating universities. A researcher-designed questionnaire was used to collect background information from subjects who volunteered to participate, each of whom completed a written voluntary consent form. A total of 940 questionnaires was collected, representing more than 81% of the population.

Twelve variables were used in the study, including gender (GENDER), high school average score for all course work (HS-AVG), high school average score for all math courses (HS-MATH), CEE total score (CEE-TOTAL), CEE math score (CEE-MATH), CEE English score

(CEE-ENG), CEE physics score (CEE-PHY), CEE chemistry score (CEE-CHEM), average score of all the college math courses taken (C-MATH), score achieved in introductory computer science courses (CS-INTRO), and average scores for computer science core courses (CS-MAJOR). Scores from subject CEE and college computer science courses were collected from student academic records.

Pearson product moment correlation coefficients (r) were calculated to examine relationships between investigated variables. The level of statistical significance was set at 0.05 for all statistical analyses. Because incomplete items were observed in several questionnaires, a pairwise deletion was used when dealing with missing values. While interpreting the results of the correlation coefficient analysis, statistical significance was not the only concern. The degree of the relationship was also examined for a possible indication of practical importance for education. A stepwise multiple-regression analysis was used to establish the prediction models. Manual control of which variables to be included in the model was also employed based on the knowledge of the importance in education of those variables.

An analysis of variance (ANOVA) was performed to test for group differences between sampled universities. Significant differences (for all cases, $F > 43.63$, $p < .001$) for most of the variables were detected between class levels and university of enrollment. All of the statistical analyses were completed by grouping students within the same class level across universities as well as students in the same class level at the same university.

CEE scores

The results of correlational analyses between CEE scores and CEE-INTRO and between CEE scores and

CS-MAJOR. Test scores from the CEE math component (CEE-MATH) were found to have a significant relationship to overall performance in college computer science programs (CS-MAJOR) for all class levels, but only for the senior level group in relationship to performance in introductory computer science courses (CS-INTRO). Significant correlation coefficients were seldom found between CEE-MATH and CS-MAJOR for individual classes. Moreover, when the correlations were significant, they nonetheless did not account for an acceptable level of variance. Rather, CEE-MATH correlated negatively with both CS-INTRO and CS-MAJOR for most individual classes. It was also observed that all of the significant correlation coefficients between CEE-MATH and college performance were negative.

This finding of negative relationships is a contradiction of results reported in a number of research studies conducted in the United States, wherein math scores were found to correlate highly with performance in computer science programs. However, in a Nigerian study by Anyanwu, a nonsignificant relationship between test scores for the math component of the joint Admission and Matriculation Board (JAMB) and overall achievement in computer science was reported.

There were significant relationships between scores for the CEE ENG and both CS-INTRO and CS-MAJOR for all class-level groups. This finding is consistent with results reported by Butcher and Muth, Oman, and Sorge and Wark in the United States. However, only 2 of the 14 classes considered were found to have significant correlations between CEE ENG and CS-MAJOR. Therefore, with less than 20% of the variance for CS-MAJOR explained, the predictive power of using CEE-ENG by itself to predict student performance in computer science programs apparently is limited.

Results similar to those for CEE-ENG were found for the science components (CEE-PHY and CEE-CHEM). Significant correlations between CEE-PHY and CS-INTRO and CS-MAJOR and between CEE-CHEM and CS-INTRO and CS-MAJOR, were identified for all class groups. However, relatively few classes reflected significant correlations for the relationships among college performance and CEE-PHY or CEE-CHEM. In addition, CEE-PHY was also negatively correlated with both CS-INTRO and CS-MAJOR for individual classes when significant correlation coefficients were observed. Because no physics or chemistry component was tested either for the SAT or the ACT, corresponding results in the United States could not be compared to findings for CEE-PHY and CEE-CHEM. However, Goodwin and Wilkes reported a negative correlation between the number of physics courses taken in high school and performance in an introductory computer science course. But because no further information was given, it would be unwise to assert any hypothesized explanation for the negative correlation between CEE-PHY and performance in college computer science programs at this time. Nonetheless, because of the low levels of correlations obtained, the use of CEE-PHY or CEE-CHEM to predict student achievement in computer science is not recommended for Taiwan.

Relationships between the total scores on standardized tests and overall college performance were seldom investigated. Only Anyanwu reported a significant relationship between total scores for the JAMB and achievement in the math components of computer science programs at all year levels. From the present study, significant correlations were detected for all class groups for the relationship between CEE-TOTAL and CS-INTRO and CS-MAJOR. The strength of the relationship between CEE-TOTAL and CS-MAJOR

appeared to increase with length of time enrolled in computer science programs. In the knowledge that sophomores took from only four to six computer science related courses during their freshman year, possibly too few to result in a significant relationship between CEE-TOTAL and CS-MAJOR, the finding of this relationship pattern was not surprising.

Significant correlation coefficients for the relationship between CEE-TOTAL and college performance often were not found for individual classes. Yet, several negative correlations were found for individual classes with respect to the relationships among CEE-TOTAL and CS-INTRO and CS-MAJOR. One possible explanation for this low correlation may be that the CEE-TOTAL variation for students within the same class level of the same university was too small to distinguish differences in college academic achievement.

CEE scores were correlated significantly with college performance for computer science students when the data analyses were completed by class level. However, these coefficients, for the greater part less than 0.45, were too low to constitute an important educational value from which appropriate conclusions could be drawn. Consequently, the predictive power of CEE scores as the sole means to predict student performance in computer science programs is apparently limited because less than 15% of the variance in college performance was accounted for in most of the correlated cases.

HS-MATH was found to reach a level of significance in correlation with CS-INTRO for all class groups, all of the coefficients were at a level of 0.20 or lower. Such low coefficients, though statistically significant, provide little of practical value that may be concluded for educational purposes. Therefore, the correlation coefficients achieved were too weak to provide evidence for the existence of a

significant relationship between HS-MATH and CS-INTRO.

HS-MATH was consistently found to be associated significantly with HS-MATH and CS-MAJOR. This finding supports results obtained by a number of studies conducted in the United States to the effect that math background related significantly to performance in computer science programs. However, the use of HS-MATH by itself to predict computer science performance is recognized as inappropriate, because less than 30% of the variance can be explained by the correlations. A significant but low correlation between overall high school performance (HS-AVG) and CS-INTRO was demonstrated for the sophomore and senior groups. However, significant correlations were seldom found for individual classes. The absence of a significant relationship between HS-AVG and CS-INTRO contradicted findings reported in the US. Similar to results found in the United States and other research, HS-AVG was consistently found to correlate significantly with CS-MAJOR for all combined classes and almost all university-specific class levels. The strength of this relationship appeared to increase with time in computer science programs. With consistent findings within all class levels for different universities, the close relationship between HS-AVG and overall performance in computer science programs was seemingly validated. The predictive power of using HS-AVG by itself to predict overall performance in computer science programs is still limited, given the fact that correlations obtain in most cases were less than .50.

Computer science courses

Good performance in beginning computer science courses is a good indicator of future success in computer science. However, this hypothesized relationship has never been

empirically proven. In the present study, the relationship between CS-INTRO and CS-MAJOR was investigated. Moreover, to avoid obscuring the relationship between CS-INTRO and overall computer science performance, the correlation between CS-INTRO and CS-NOBCC.

Significantly high correlation coefficients were found for all class groups and all individual classes in the relationship between CS-INTRO and CS-MAJOR (r range from 0.54 to 0.88) and between CS-INTRO and CS-NOBCC (r range from 0.32 to 0.77). Findings for this close relationship between CS-INTRO and CS-MAJOR support the common hypothesis that good performance in the first computer science course taken is an indicator of future academic success in the computer science. Therefore, the adequacy of using course performance in introductory computer science courses as an indicator of overall performance in computer science was validated for college students in Taiwan.

Prediction models

Student performance in beginning computer science courses was claimed to be reliably predicted by pre-admission variables in studies conducted in the United States. However, a low model R^2 values in excess of 0.30 were seldom found in these studies. Similar results were obtained for the prediction models of CS-INTRO. Although significant linear models were generated for combined class groups, the R^2 obtained was 0.12 or lower for the junior and senior groups. An R^2 at this level is the equivalency of a random guess prediction. Thus, the practical value of these prediction models is limited. Moreover, no significant linear models were generated for the senior class of Universities D and E. Hence, when these findings are considered in combination, they are inadequate to conclude that performance in the introductory computer science courses can be predicted

by the variables investigated in the present study.

Only limited research has dealt with performance prediction beyond the level of introductory computer science courses. Among these studies, Butcher & Muth reported an R^2 of 0.42 for a prediction model for first semester GPA, with high school GPA and ACT-MATH included in the model. Shoemaker found that high school GPA and College Board math achievement were the best predictors for major GPA for college computer science students ($R^2 = 0.34$). Anyanwu indicated that the overall college performance of computer science majors could be predicted by high school GPA, prior computer experience, and GPA for high school math. However, a low model R^2 was observed.

In the present study, R^2 values of 0.30 or lower were obtained for models predicting CS-MAJOR for different combined class groups. Different variable combinations of high school performance and CEE scores were selected into the prediction models. Other than GENDER, no other pre-admission variables were entered in the prediction models, indicating the lack of predictive power for these variables. Similar to results from other studies, the overall predictive power of these models was also apparently limited.

Considering that CEE-TOTAL is likely to continue to be used as the primary selection criteria for college admission in Taiwan, all subject CEE scores selected into the prediction models were replaced by CEE-TOTAL, and the models were then refitted. Similar results were obtained, with the model R^2 decreasing slightly. This result indicated that a similar predictive power would be obtained if only CEE-TOTAL and HS-AVG were used for the prediction of CS-MAJOR.

As described previously, CS-INTRO was found to

closely relate to CS-MAJOR. The R^2 for the models increased significantly when CS-INTRO was entered into the CS-MAJOR prediction models for all the combined class levels and individual classes. This finding further supported the close relationship between CS-INTRO and CS-MAJOR.

Gender differences

Although gender differences have been an important issue in computer science education and have frequently been subject to investigation, significant gender differences in course performance have seldom been found. Nonetheless, several researchers have reported that females tended to receive higher grades in beginning computer science courses.

This study found no significant gender differences for CEE-TOTAL, CEE-CHEM, or CEE-MATH performance. Male students achieved relatively higher scores than their female counterparts, though the score differences did not achieve required significance levels. However, females achieved significantly higher scores in HS-MATH, HS-AVG, CEE-ENG, C-MATH, CS-INTRO, and CS-MAJOR. Therefore, though the gender differences in CEE scores were not significantly obvious, female students apparently outperformed males with respect to academic achievements at both the high school and college levels. GENDER, when used as an indicator variable, was found to be an effective predictor for the CS-MAJOR prediction model for sophomore groups.

However, GENDER was not selected into the CS-MAJOR prediction models for any of the senior classes. Furthermore, when CS-INTRO was entered into the models, GENDER became nonsignificant for all the prediction models generated for CS-MAJOR. As a result, different prediction models for males and females should

not be a necessity for the prediction of CS-MAJOR using models generated from this study.

Significant correlations were found between CEE scores and performance in college computer science. However, the predictive powers of these scores, considered in the absence of supplementary information, were found to be limited. Moreover, CEE-MATH was negatively correlated to performance in both introductory computer science courses and overall coursework for the computer science programs of many classes. These results suggest that reassessing the predictive validity of CEE scores may be necessary if prediction of performance in the college level is the main purpose of such examination.

CEE-MATH was not closely correlated to either CS-INTRO or CS-MAJOR. In addition, negative coefficients were observed whenever CEE-MATH was selected into the prediction models for CS-MAJOR. These results failed to demonstrate the close relationship between CEE-MATH and college performance in computer science programs, as reported in many investigations in the U.S. However, a strong relationship was found between course performance in college computer science programs and HS-MATH. Combining these findings, the effectiveness of the continued use of CEE-MATH to measure student math ability is questionable. Because of its lack of power for predicting future achievement in computer science programs and incapability in measuring student math ability, the use of CEE-MATH as a major-selection criterion for entering college computer science programs is considered inappropriate.

A limitation of the predictive power of CEE-TOTAL for predicting CS-MAJOR was found. Similar results in predicting college performance were reported by other

researchers, though students in other than computer science programs were used. Currently, college admission in Taiwan is principally determined by CEE-TOTAL. A score within the upper 50% percentile for certain CEE subjects is required for special program admissions at some universities. High school performance has never been used for this selection purpose.

However, high school performance in math courses and overall coursework consistently correlated well with performance in computer science programs. In consideration of this result, if a different admission process were employed in the future, it is suggested that high school performance be included as an admission criterion for computer science programs. It was not surprising that no gender differences were found for the scores CEE-TOTAL, given that students were admitted to specific universities based primarily on their CEE-TOTAL scores.

Males achieved higher relative scores, significant gender differences were not found for CEE-MATH, CEE-CHEM, and CEE-PHY. However, female students in computer science programs achieved significantly higher scores in the CEE language component (CEE-ENG). Furthermore, female students also outperformed males at both the high school and college levels. Several studies conducted in the United States reported similar results.

The use of beginning computer science courses as a gateway for entering a computer science major has long been practiced in the United States. However, college majors are determined based solely upon the total CEE scores when students are admitted to a university in Taiwan. Performance in the first computer science course is not taken into account for admission purposes. Findings on the relationship between CS-INTRO and overall course performance in computer science programs

supported the common hypothesis that good performance in the first computer science course may indicate future academic success in complete computer science programs. Predictive powers were significantly increased when CS-INTRO was included in the prediction models. If CS-INTRO could be used with other predictors, a more satisfactory selection outcome may be expected than when using CEE-TOTAL as the sole basis for admission to a college computer science program. Hence, it is suggested that CS-INTRO be included in prediction models of overall performance to select successful students for computer science programs in Taiwan, if the admission process were changed in the future so that high school graduates were admitted to a university without claiming a college major until the end of the freshmen year.

Some of the inconclusive results of this research, in combination with findings from previously conducted studies, suggest that performance prediction findings should be viewed cautiously. Butcher and Muth pointed out that studies using standardized test scores all identify high school GPA as important parameters, but nonetheless leave more than 50% of the variance unexplained. Chin and Zecker warned that the use of a mathematics pretest as the only success predictor for computer science courses was inappropriate. Because test scores tend to improve with practice, Sharma questioned the use of test scores as the sole screening tool for college admissions. Sorge and Wark also suggested that factors other than academic ability were involved in succeeding in computer science programs. Therefore, as indicated by Oman, the prediction model developed using pre-admission variables should be supplemented with other methods if academic advice or selection of successful computer science majors is the principal purpose of such

a process.

One of the major purposes for identifying effective predictors of college performance is the intention to make better use of limited resources by helping students make reasonable choices of college major. However, as Butcher and Muth indicated, some of those who have been classified as unlikely to succeed in beginning computer science courses have been found to perform well in subsequent courses. Therefore, the practice of individual success prediction for academic performance should not be used to discourage students with high motivation in computer science studies. Instead, it would be more appropriate to use information from performance prediction as a means to better advise high school graduates in Taiwan in about choosing college majors.

Limitation of research

The primary limitation can be directly linked to the voluntary nature of participation in the survey. Although the sample represented more than 81% of the defined population, some students were absent from classes during administration of the questionnaire. As a result, background information and academic records for these students were not available. Therefore, generalization of the findings from this study to the entire population of computer science programs must be approached with caution.

Only computer science majors currently enrolled in a university in Taiwan, and not students in other computer-related programs, were included within our study. Generalizing the results from this study to populations other than computer science majors is thus inappropriate. Therefore, future research should be conducted to determine if similar results can be found for students enrolled in other computer-related programs.

Clarification of the predictability of student success in computer-related programs may be obtained if the results of such research can be combined or compared to the findings reported in this study. In addition, conducting research to verify if the prediction models developed for the sophomore and junior-level students surveyed for the present study remain valid may be necessary.

All information regarding high school performance was self-reported by the participants during questionnaire administration. The restricted number of female students in computer science programs also is recognized as a limitation of this study with respect to the examination of gender differences.

Use of Computer Teaching

Computers are more accessible to faculty than ever before, and computer capabilities have increased dramatically. Despite this increase of technology in schools, integration of computers by faculty into the classroom has not kept pace. Therefore, investment in technology cannot be fully effective unless faculty receive necessary training and support and are willing to become fully capable of using these technologies. Current research points to such environmental factors as a supportive administration, sharing of resources, availability of support staff, and effective training. In addition, there are personal social cognitive factors that affect whether a faculty member will take advantage of the resources available: faculty attitude, anxiety, self-efficacy, willingness to make a time commitment and face the risks involved with using technology, competency, beliefs and perceptions of the technology's relevance, and lack of knowledge.

Before teachers use instructional technology (II), they must learn to use it, whether independently or with the help of a trainer. Teachers may or may not be willing to attempt that training. Before examining what factors will affect a teacher's choice to seek training, it is helpful to review a training model. Cagne and Medsker explored several human performance models to diagnose training situations and to prescribe effective solutions. A front end analysis includes a diagnostic branch to

determine deficiencies, hypothesize and test probable causes, and plan solutions to training. The front-end analysis (FEA) first specifies actual and desired performance, deficiencies, and the potential value of overcoming those deficiencies. Second, a general cause hypothesis is determined, such as lack of skills, poor environment, or low motivation. Third, the probable cause is tested. Finally, planned skills, knowledge, information, environmental support, and motivation and incentives are established.

A behavior-engineering model categorized six factors that contribute to or inhibit human performance into two areas, personal factors, including skills and knowledge, capacity, motivation, and environmental factors, including data or information, tools and setting, and incentives. Gagne and Medsker explain that capacity requirements cannot normally be addressed through training and therefore are not relevant issues for this article. Environmental factors external to the individual and, other than acknowledging their importance, leave them beyond the scope of this review. These models can be used to categorize and examine factors identified in the literature as significant predictors of whether a faculty member will choose to use computers for instruction.

Teachers are less likely than other professionals to use computer technology. Using the FEA model, the desired performance, which should be determined first, is the use of computers for instruction, the potential value of which has been documented in the literature. Computers provide advantages for the instructor. For example, Armstrong pointed out that computers can ensure that adding or updating lecture material is easier, delivery of information is consistent from class to class, the technical quality of the presentation does not diminish with age, and presentations can be designed to

march the exact needs of the students. The value of integrating computers can be also seen in student outcomes. For instance, in comparison with traditional classrooms, well-designed computer-mediated instruction has been shown to improve student scores, decrease learning time, and improve student attitudes toward learning.

The next step of the FEA is to identify general causes. These include environmental factors: availability of computers in the classroom, sharing of resources, a supportive administration, and a strong support staff.

Lack of skills, knowledge, and information have also been clearly identified: Roberts and Ferris stated that barriers to technology integration included lack of knowledge of available hardware and software, time commitment, and the risk of using technology. Personal factors related to low motivation, incentive, and affect are also identified: Anxiety levels, self-confidence, and perceived relevance influence faculty intentions to use computers in instruction. There is a significant correlation between number of computer literacy courses taken and attitude, and competence is significantly related to prior training. Dusick and Yildirim also concluded that computer competence and prior training are significant predictors of whether a community college faculty member will use a computer for instruction. In a path analysis, competence and courses were found to have the only significant direct effects on computer use in the classroom. Competence was positively related to all other variables in the model: courses, having a home computer, and attitude. Having a home computer was also significantly related to attitude.

Some faculty members have incorporated technology into instruction, others have little knowledge and resist it because they are not fully aware of its implications and

uses. Others, although aware of the technology, are cynical about its benefits and likely do not see a need to change. Still others, although technically proficient, are unable or unwilling to relate technology-assisted instruction to student satisfaction and performance. Meltzer and Sherman propose that ongoing staff development, including training, release time, and support, are critical to the successful integration of technology into the classroom. Teachers attend staff-development programs to learn specific instructional skills, improve knowledge in their disciplines, and become experts. In training sessions, teachers take on the role of student.

The social cognitive view of self-regulated academic learning provides a model for the teacher as student. Zimmerman describes a model of self-regulated learning that assumes a reciprocal causality among personal, behavioral, and environmental influences. The model also posits a central role for self-efficacy. Just as any other student in the classroom must be a self-regulated learner to be successful, the teacher as student must be aware of personal, behavioral, and environmental factors. Self-regulated learners must perceive acquisition of proficiency as within their control, determine specific goals, and make a commitment to those goals. Finally, the learner must regulate his or her behavior and, if possible, environment in concert with those goals. Self-efficacy will play an important role in the learner's success or failure. The following social cognitive factors are presented in the literature as major contributors to faculty use of IT. Most of the constructs involve some level of training and thus invoke the teacher-as-student model.

A number of reasons account for the minimal use of computers by educators; attitudes are influential. Woodrow believes attitudes influence not only whether

one accepts computers, but also such future behaviors as using the computer as a professional tool and integrating computer application into the classroom.

Attitudes are defined as an evaluative disposition based upon cognitions, affective reactions, behavior intentions, and past behaviors; that disposition can influence future cognitions, affective responses, intentions, and behaviors.

The Computer Attitude Scale developed by Gressard and Loyd divides attitude into four subscales: computer anxiety, confidence, usefulness, and liking. Computer anxiety is associated with computer interaction and is disproportionate to the actual threat presented by the computer.

The two most common terms found in the research are computer anxiety and computerphobia, and both terms are occasionally used synonymously. For purposes of this review, computer anxiety is considered to be a generic term that encompasses all levels of anxiety. Questions arise regarding why faculty have anxiety about computer interaction, how the anxiety can be identified, and whether the anxiety can be dealt with. Avoidance of computer interaction is the primary indicator of computer anxiety. The etiology of computer anxiety has been reviewed from several theoretical stances. It may be a result of low self-efficacy, low expectations of outcome, or lack of reinforcement. It may also be examined from a clinical standpoint, ranking the anxiety from mild to severe. Research literature points to an individual's prior computing experiences, attitudes toward computers, perceptions of self-efficacy, and expectations of success as additional indicators of anxiety. There appear to be increasing levels of anxiety from minor levels of discomfort to highly technophobic anxiety.

(such as expert systems and intelligent tutoring facilities) can be used to deliver deep knowledge and remediation embedded within the context of original learning/training tasks. Through the use of EPSS techniques, students and staff can thus be provided with more complete, varied, valid and stimulating knowledge.

Numerous examples of the use of EPSS techniques within education are now starting to appear in the literature. Stevens and Stevens, for example, describe the 'School Year 2000' initiative in Florida, USA. This is intended to provide students, teachers, administrators and others involved in the education of children with performance support tools in eleven different areas - including curriculum planning, instructional management, assessment, delivery of instruction, access to educational resource materials, and so on. Similarly, within a university context, Barker *et al.*, have described the application of EPSS techniques for the operation of an electronic, open access student information service' (OASIS). The electronic OASIS is a basic mechanism to support ECD based upon the use of electronic lectures and various forms of automated (computer-based) assessment of students.

The three case studies described in this section illustrate some of the ways in which ECD is currently being realized within our own organization. They deal with the use of electronic lectures, distributed performance support and the embedding of pedagogic structures within electronic course material.

Electronic course delivery necessitates thinking about new ways of making teaching and learning resources available in electronic form. One of our first experiments in this area was to look at the feasibility of using electronic lectures as a mechanism for: improving the quality of 'stand and deliver' lecture presentations;

and making available 'augmented' lecture material as a self-study resource for open and distance learning activities. In order to study potential improvements in the quality and effectiveness of conventional lecturing techniques, we persuaded a number of staff members within our organization to adopt the use of computer-based presentation packages. Staff used these packages for: creating their teaching material; and subsequently delivering this material 'live' to student groups in conventional lecture theatre environments that had been equipped with appropriate projection equipment. Student attitudes to the use of these electronic lectures and their comments on the quality of the materials were assessed using questionnaires', the results are documented in detail in Tan. Two different approaches to the development of electronic resources were explored. First, the conversion of existing material into a more dynamic electronic format; second, the creation of new lecture material directly in electronic form. Each of the authoring processes was studied in some detail in order to identify problem areas and specify appropriate tools that could be used to overcome the difficulties that staff encountered in using electronic authoring packages.

Once a stock of electronic lectures had been created and stored in a central database facility, the second phase of the study was initiated. This involved making electronic lecture material available to students in various ways for self-study purposes. Three different approaches were considered:

- distribution on conventional floppy disk;
- publication on CD-ROM;
- providing access to lectures via the department's intranet facility.

In each case, book and library metaphors were used to

facilitate end-user access to the resources. Undoubtedly, one of the most useful approaches to self-study access was the intranet facility since this allowed the incorporation of student self-assessment material (in the form of on-line tests) that could be automatically marked by the computer -with feedback being given directly to students and sent back to teaching staff. Of course, just taking electronic lecture material and making this available to students is not a sound pedagogic strategy since some extra accompaniment is needed in order to compensate for the absence of the lecturer's narrative. We are therefore currently investigating audio, graphical and textual techniques for augmenting lecture material in various ways. These techniques will be supported by appropriately designed automation tools to facilitate the necessary augmentation techniques.

Distributed performance support

Implicit in the work described in the previous case study was the underlying use of electronic performance support techniques for the creation of highly supportive teaching and learning environments. As well as the creation of electronic lectures, another important facet of the work was the creation of an electronic, open access student information service from an existing manual system. The Electronic OASIS was designed in such a way that it formed a highly distributed electronic performance support system (DPSS).

The Electronic OASIS system that we developed was based upon the same type of client/server technology as is used within the World Wide Web (WWW). Indeed, the only difference between our system and a conventional WWW server is the fact that our resources are not publicly available to people who are not members of the university. It therefore uses the same approach to resource provision as is used in the WWW. That is, materials are 'marked up' using HTML (HyperText

Markup Language) and Java and are then mounted on an intranet server. Users can then access these resources (via the campus-wide network) using a standard Netscape browser. Common gateway interface (CGI) programming techniques are used in conjunction with the browser to facilitate on-demand on-line testing of students and the administering of interactive questionnaires relating to the quality control of courses.

As well as making available electronic lecture material for self-study purposes, the intranet facility also provides access to an electronic library of study resources to support the various courses that we run. Access to previous exam papers (with solution guidelines), case study material and practical class exercises is also possible. Students (and staff) can obtain copies of any of these materials (electronically) using any of the computer workstations that are attached to the local area network facility that forms the backbone of the distributed performance support system.

In order to extend this work to other departments and divisions within our university, a number of other electronic OASIS systems are being created in several of the other administrative units of our organization. The long-term intention of this DPSS project is to provide a seamless electronic course creation and delivery environment that is available to all students and staff of the university - no matter where they happen to be located. Fundamental to the realization of this goal is the provision of suitable interactive environments to facilitate the design, development and sharing of electronic course materials that embed a wide range of different pedagogic strategies. Some of the issues involved in doing this are discussed in the following section.

Since knowledge sharing implies far more than simple information access, it is important that the

mechanisms which allow information to be incorporated into a person's cognitive functioning are considered. In order to investigate this more closely, Race's model of learning was applied to the development of educational software designed to transfer knowledge about statistics to adult learners. At this stage, guidelines had already been developed based upon Race's model, however, they were still in an untested form. The objective, therefore, was to design a learning package which would take into account all four aspects of Race's model: Wanting; Doing; Feedback; and Digesting. In the process of designing, implementing and evaluating the learning package a number of clarifications and developments were made to the guidelines. These developments resulted directly from the experience of using the model in a practical setting and analysing the responses of participants.

The guidelines were employed in the design of a computer-based learning package (called 'Statistics for Psychologists') aimed at teaching statistics to newly starting undergraduate psychologists. Since the package was directed at students who were about to undertake a traditionally taught course, open-learning was felt to provide the most appropriate mechanism.

Open-learning systems provide flexible access for students to training materials. This gives students some choice over when they study, the length of each study session, and also the pace at which they progress through the learning materials.

Although open-learning systems do tend to provide such benefits, there can often be drawbacks associated with such an approach. First, the large degree of flexibility provided means that it can be impractical to provide on-hand subject-expert support to assist information transfer. In addition, system users may not

know the limitations affecting knowledge transfer and may therefore be unable to take remedial action. As a result, it is essential that mechanisms such as knowledge testing are embedded in information sharing applications as cognitive transfer tools for users.

Table 1 Some basic guidelines for use in educational software

1. Wanting must be consciously programmed into courseware.
2. Two ways of embedding wanting: increased value and increased enjoyment.
3. Avoid passive interaction.
4. Support practice and/or trial and error learning.
5. Provide students with a sense of progression.
6. Encourage use within a social context.
7. Embed computer-based student evaluation.
8. Encourage reflection away from the computer environment.

The 'Statistics for Psychologists' learning application is designed to take account of pedagogic strategies and guidelines to facilitate knowledge transfer. The two key mechanisms employed in this regard are highly interactive protocols and computer-based assessment. These mechanisms can improve motivation, assist in the organization and assimilation of information, and help remediate inadequacies in knowledge transfer. In this application, users select answers from either the answer button bar or the table of data which forms the basis of the questions. This encourages users to organize their thoughts, identify limits in their understanding, while at the same time providing a highly interactive environment.

Inservice Education

The main focus of this chapter is on the in-service education of teachers and teachers' centres as established over recent years. This chapter, however, argues for a complementary development of professional centres based upon institutions of higher education as an important alternative and extension of the concept of teachers' centres. The thrust for the current national review of in-service education was provided by the report of the James Committee in 1972(1) in which it was argued that "the best education and training of teachers is that which is built upon and illuminated by a growing maturity and experience. Teachers' centres organized outside the colleges of education can, of course, make a major contribution to this provision. It is, however, vital that those agencies providing initial training of teachers should also play a central part in in-service education.

The proposals regarding initial training assume an established pattern of continuing education and training of teachers, and take the twin objectives of initial training as being to equip the student to be as effective a teacher as possible in the first assignment, and to provide him with a basis upon which his in-service training can be methodically built. Equally they assume that the student has, in the formal sense, "completed" his initial education and is now sharply motivated towards teaching.

Following the publication of the report, in-service

training has become detached in public argument from the question of initial training and the development of professionalism in teachers. However, if such a view predominates and in-service training is separated firmly from initial training, it will fail to realize its full potential. The main argument for seeing that colleges of education and other training bodies have a continuing role in induction and in-service work is based upon their continuing responsibilities for initial training of the nation's teachers. It would be unsatisfactory for such institutions to carry out initial training unless in their professional work they are entrusted with some responsibility for the continuing education of teachers.

It is extremely difficult to generalize about 150 institutions varying widely in size, location and character. Colleges will shortly be designated as further education institutions, and various forms of diversification will follow.

A small number will merge with polytechnics, and one at least with a university. Others will merge with colleges of technology, and some remain independent but with additional courses in fields other than teacher training. The reference groups for the colleges will be more diverse, and they will be less dependent upon links with a university. In in-service training the regional authority will be a consortium of interests, in which the university and college will be only a part, with teachers and local education authorities playing a substantial role. For the purpose of this chapter, however, it is assumed that the institutions of which we are thinking have a significant higher education role, with a central core of teacher education and substantial in-service responsibilities. This would be true whether the colleges are acting independently or within the context of a much more generalized further education provision- normally of an advanced kind.

The professional centre

It is hoped that all higher education institutions with a major concern with in-service training will establish a professional centre. In a limited number of cases it is possible that a small college may, in fact, become a professional centre concerned solely with in-service education and training. In most institutions, however, work with qualified teachers will be a part only of the purpose of the college. Indeed, any institution concerned solely with in-service training will be able to provide only a part of what a teacher essentially needs as a fully professional person for whom continuing opportunity for personal education is also of significance. However, in-service education with the scope now proposed cannot be sustained by the part-time -and frankly peripheral - attention which many colleges give to it. It is essential to concentrate staff, resources and organization to serve the special and continuing needs of practising teachers. One way of ensuring this concentration is through the establishment of a professional centre which is the responsibility of a senior member of staff, with its own board representative of the various interests in the field of in-service education. If a college has a series of schools or faculties, then such a professional centre should have equivalent powers, a substantial budget and a well-articulated policy which has been agreed by the college's academic board, governors and local education authority. It should have power to respond to requests, as well as to initiate major programmes; it should be given responsibility also for research and inquiry in what is the most critical field of development in the whole of teacher education. Such a structure would enable the colleges to make a substantial contribution to induction, in-service and innovation.

The induction period is the essential bridge between training and teaching, and much of the quality of the

profession and the response to future in-service opportunities are dependent upon what is done in the first year of teaching. It is also a key stage in the professionalization of the teacher. As the White Paper points out, "induction should offer a systematic programme for professional initiation, guided experience and further study. To do so, teachers must be released for not less than one-fifth of their time for in-service training." The whole direction of courses and guided experience should be to support and help the new teacher to become more skilled and adequate as he works his way through the various stages of his concentrated and decisive professional experience. Central to the entire development will be the role of the professional tutor. The colleges have an important role to play, although from the beginning it must be clear that this should in no way be prescriptive. It is neither possible nor desirable to sit down and plan a 1 day a week course for the 200 inductees who may take up appointments within easy travelling distance of a college. It is necessary to be familiar with the schools in which the new teacher will be working and to have close liaison with the professional tutors, the advisers and headteachers. The programmes of support and guidance should be closely related to the individual needs of the different teachers, with group seminars, access to resources, and introductory sessions common to all working within particular kinds of school. Much else will be individual and group work, done sometimes in the college, sometimes in a teachers' centre, and often in school.

One approach would be to have an "assigned tutor" who would establish and maintain a working relationship with a group of schools. The tutor would assist with in-service programmes for such schools, make a contribution to teaching in the school and hope to gain the confidence and respect of the head and his staff. In

co-operation with the professional tutor he should meet the new teacher at very beginning of his year and, if possible, before he has actually taken up his appointment. The need for more students to be appointed to specific schools and to know about them well before they take up their jobs in September is urgent if one really wants teachers to feel some commitment to the schools and children with whom they are working and to feel that are being treated as properly professional people. Any new teacher faces problems and one task of the assigned tutor is to try link the teacher's induction period study both to his classroom difficulties and to whatever kind of initial he received. While the "assigned tutor" should be seen to be closely identified and actively co-operating with the professional tutor, he should also provide opportunity for contact outside the context of the school, and provide a listening ear for the young teacher without being identified with the status system either within the school or within the authority. The college could provide a social base for the young teacher, as well as full and free access to the library and to audio-visual and other resources. The new teachers should be given the opportunity also to help trainees by talking to them about the ways in which they are tackling the problems which arise in the first year. This is one extremely important way in which a college role in induction has particular value for initial training.

The "assigned tutors" from the college should be active professionals working also in a school of professional studies concerned with initial training. They will be mainly field-based tutor working more outside the college and in the schools than inside the college itself they will be closely identified with professional tutors, teachers' centre wardens and practising teachers. Indeed, they should form part of a wider professionals group which plays a role in both initial and in-service

training. This, of course, will only be possible if the college regards initial training and induction as part of one continuous process. The core of such an approach is the day-to-day professional experience for the practising teacher. This accepts the need for early concerns, the need to understand the way in which particular children learn, why teachers have certain attitudes, what resources are most appropriate for children of different ages and abilities, the effects of home background, the attitudes of parents, an understanding of the questions which children ask, and the ways in which answers can be articulated or discoveries made. New teachers will need help in recognizing the qualities which are most valuable in particular situations: the usefulness of particular kinds of knowledge and understanding gained from higher education, the value of critical analysis, using such techniques as simulation and micro-teaching, and the consideration of the values implicit in certain forms of the curriculum, and ways of assessing the success of teachers and of children. Young teachers more than their elders are very alive to such issues, but impatient of an approach which is too highly theoretical -at least at the beginning.

A seminar and tutorial approach must be the one adopted for the induction year. This will involve the young teacher in a sharing of experiences and a slow realization of ways in which it is possible to be critical but constructive about one's own performance. It will also help in resolving some of the problems of individual children and of groups by suggesting strategies for using resources, for pacing one's output, and for keeping one's sincerity as well as one's sanity. It would also be the responsibility of the "assigned tutor" and the professional tutor together to help the young teacher to see the way in which he is developing and changing, so that he is able to assess for himself ways in which he is failing and

succeeding so that each year he makes progress or seeks out those who can help him to find areas of work which enable him to greater success. This is the essential challenge of the induction year.

In-service

The professional centre at the college should cater first of all for the individual needs of the teachers in the region as a resource centre, and secondly as a centre for various kinds of courses. The major thing to emphasize, however, is the role of the centre as a resource. The centre will need to be a place with good facilities, an educational technology area, spaces to make things, to experiment with materials and see examples of work done by children and of publications and apparatus for use in schools. There should be a major social area, common-rooms, a cafeteria and accessible parking areas. In addition, all parts of the college should be open: library, where available, laboratories, access to computers, further social facilities such as sports and bar, etc. For the use of the more obviously social facilities some fee may well be charged. It will certainly be necessary to finance from the authority the kind of materials bank which would be involved, and the additional pressure which will be put upon the library and other resources. Initially the major use will be made by teachers, but it is essential from the beginning that the needs of social workers, youth and community workers, and others working in the area should be recognized: indeed, it is important that in-service education should not be organized separately from other services to the community. Teachers will lose out if their continuing education is seen as separate from the improvements of public provision in higher education generally. Also the opportunities for various professions to get together both socially and professionally should be seized. This may begin with a common concern for children, and then extend to the

linked problems which affect families in the area, as well as the various services which are provided. It would however, be preferable if colleges offering interprofessional opportunities were also to train such workers at the initial stage, as the same advantages which would accrue for teacher trainers being involved with in-service would also affect the initial training of social workers and others. Above all, it is now important to work out a realistic budget for such activities, to relate the various agencies together, and to determine the priorities in terms of development.

The modern approach to course design advocated by the White paper is for the use of units or modules which enable courses of various lengths and patterns to relate to each other and to lead eventually to substantial awards. Thus, although there will always be a need for specific and concentrated courses in limited areas, it is no longer necessary to assume that are the only kinds of courses that will deal with the urgent and relevant concerns of teachers, whereas the longer, high-level courses are assumed somehow to escape the need to be relevant and appropriate. The overwhelming desire indicated by Brian Cane and H.E.R. Townsend is clearly for in-service Bachelor of Education degree courses available both part-time and full-time. A critical problem is, however, to ensure that the new B.Eds. are much more professionally relevant and flexible than those which exist at the moment. The flexibility should be established not only to fit in with the needs of teachers in professional terms, but also in relation to the opportunities they have for leave and for part-time study. Thus, teachers should be able to obtain qualifications by a wide variety of means: by one-year, full-time study, one-term, full-time interlocking with part-time study, as well as entirely by part-time study. The use of vacations and weekends should be exploited, as should one-day

and half-day release. Tutorial supervision in schools related to curriculum development, and emphasis upon independent study should all free the teachers to tackle urgent professional questions at a good intellectual level. The fact that teachers will be members of the boards responsible for planning courses of in-service training should lend in-service programmes greater relevance to the teaching situation.

A professional centre would enable teachers to have access to higher education courses and to read for a Bachelor of Arts degree as well as for a B.E.d. However, in the main the degree normally offered would be the B.E.d. whilst the approach to main subjects, for example, English, might pay particular attention to the needs of teachers working in educational priority area schools, or to the problem of language and communication at a very Practical and specific level.

On the other hand, a study of areas of literature might lead the students to question the approach of Dr. Halsey and his team in their volume on educational priority, that is that the curriculum in educational priority area schools should be aimed primarily at the critical and constructive *adaptation* of children to the actual environment in which they live and that the balance of the curricular diet should change from "academic" to "social" with reality-based themes forming the staple intake. Again, an English department might pay particular attention to reinforcing the teaching of English to the immigrant child.

There are many practical questions to be answered, although experienced teachers will undoubtedly see, as June Derrick did, that the teaching of English is only one part of the cultural growth of an immigrant in a new environment. Thus, short and highly specific courses on a subject basis will inevitably lead to more substantial and

deep considerations of role of the teacher and the purpose of the school.

One of the major considerations which led the James Committee to put in-service training at the top their priority list was the impossibility of preparing a teacher at the beginning of his career for all the responsibilities he is going to face in a world of rapidly developing social and cultural change.

The current inability of so many schools and teachers to cope with the rapidity of change in curriculum, methods of teaching, and changing motivations and attitudes of children is a powerful argument for a national system of continuing education for teachers.

Attempts to maintain a sabre-toothed curriculum or to return to a traditional relationship with children are both doomed to failure when one comes to analyse the present pace of change in school organization, in social demands, in learning content and teaching methods. However, it must be said that a large number of brilliantly innovative programmes developed by the Schools Council and independent foundations have failed to make any effective impact on the children for whom they were intended. It is, therefore, essential that professional centres should aid the vital task of establishing curriculum change in schools, and thus crucially affect the standard of education which children receive. This thesis has been well argued by Hoyle, who has written persuasively on the strategies of curriculum change.

By curriculum change is meant changing methods, materials, hardware, school organization and educational principles, i.e. virtually any sort of innovation at the school level. It also accepts that the fundamental aim is to improve schools and the educational experiences of

The possibilities for a qualitative development in their own process of learning was less important. The results from the questionnaire indicated that there was too little weight put on implementing the project among the students. Over 50 per cent were of the opinion that they should have been given more information about the project before it started and, in the interviews the students seemed insecure about the purpose behind this way of organising the study. They saw the immediate value of using the computer as a tool in many ways, but they did not understand the purpose of being connected to a teacher at another school through the network. This was particularly so for those students in the *partly distributed areas* of study.

The second issue that Bjorgen emphasises is that students should have knowledge about where important information sources for their study can be found, and how to use them. In the distributed model the students have access to different computer-networks of which they can take advantage in order to expand their study resources. What becomes especially important is to make sure that the students have approximately the same amount of knowledge about this new technology - otherwise it can increase differences amongst them. In the SIRNET-classes there were always some students that knew more -about computers than others, and even more than the teacher.

Results from the evaluation showed that the students co-operated to a very large extent, both on questions about the subject and on technical questions. The main impression from the interviews was that they were not aware of the fact that cooperation could promote their process of learning. By pointing to the positive aspects of increased cooperation, their awareness of an important goal of the project could have been increased.

A more qualitative process of learning, in the sense that students take more responsibility, can be promoted through greater flexibility, for instance through the students' control over working-hours and effort. The results from the SIRNET-evaluation showed that the students in the *completely distributed* course felt, to a significantly larger extent, that they had control over how much time they spent on the subject.

Another important aspect is that students know what is the goal of their learning, what is to be learned and what are the criteria for good learning. It is therefore important to inform the students about the goals of the project, what implications it has for them, and what the expectancies are related to the new model. In SIRNET no special criteria for evaluating the students were developed. Teachers evaluated the students' performance by traditional norms. Alternatively, one could have chosen to develop criteria related to a more independent working-style.

In addition, knowing the goals for ones own learning may effect the motivation to study in a positive direction. Through SIRNET, the schools were given both extra financial resources, computers, new ideas and inspiration. As a result, most of the students in SIRNET found it more motivating to work within a distributed model than in the ordinary teaching-situation. The main impression was, however, that this motivation was brought about by the excitement of new technology and extra attention. The students were not so much concerned with their process of learning per se in the distributed model.

In SIRNET some students, however, expressed frustration because they did not know the 'net-teacher'. Their only possibility of communication with this teacher was via the net, and they felt that any contact had to

planned for properly in advance. In the *completely distributed* subjects group the teachers were introduced to the students at the beginning of the semester as they travelled around and visited the cooperating schools. As a consequence, these students and teachers perceived their communication as good.

The last issue in Bjorgen's operationalisation of a qualitative process of learning is creativity. He claims that students must be provided with the opportunity to utilise creativity in their school-work. The question is whether computer-networks promote such creativity. On the basis of this evaluation, no clear answers are forthcoming concerning this. However, it can be imagined that access to databases and sources supplying relevant information, and the possibility of network-connections to the rest of the world, would provide the requisite stimulation.

Teaching Skills in an Electronic Mail Environment

The appropriateness of computer-mediated communication (CMC) (that is, electronic mail (e-mail), computer conferencing and electronic bulletin boards) for higher education purposes has been widely recognized. An important feature of CMC is its potential for creating learning environments that promote collaboration and interaction between learners. Consequently, it has been applied in education especially when collaborative interaction has been an instructional priority. This interaction priority is closely related to the knowledge production activities of academics who create, transform, communicate, store and retrieve knowledge. The demands of this 'knowledge work' can, to a large extent, be met by both time- and location-independent collaborative CMC-interactions with colleagues and peer students sharing common goals and interests.

Although CMC has been used mostly in distance studies at the college and university level in connection with both undergraduate and postgraduate courses there are experiences concerning its use in on-campus settings too. In the study reported here CMC was used in an on-campus credit course in order to help students practise and improve their argumentation skills.

Argumentation is defined as a process of presenting reasons to support one's opinions and conclusions. For

two important reasons, its role in an academic context is fundamental. First, a major characteristic of academic discussions is an aspiration to present well-considered reasons in order to convince the audience of the justification of the presenter's standpoint. Second, argumentation is a fundamental tool for proving the validity of scientific knowledge.

In addition, argumentation may also help people cope with the demands of the new information society in which the supply of information is increasing all the time and its means of production are constantly developing. In order to manage this information flood one has to be able to select which information is relevant and then make critical assessments between the numerous alternatives.

Effective selection and choice presuppose developed skills in argumentation and critical thinking. Consequently, the teaching of argumentation skills is an important mechanism for achieving the objectives of higher education studies: to educate people who are able to supply, select and assess knowledge independently. Despite the fact that CMC has been found to be well suited to higher education, academic argumentation has received only limited attention in the CMC literature. On the other hand, there are a large number of descriptive studies relating to students' experiences and perceptions of CMC as a learning environment. However, fewer studies have focused on the learning effects of CMC by evaluating Students' outputs after engaging in CMC studies. Furthermore, in those studies that have concentrated on students' outputs the focus has mostly been on learning outcomes at a general level not on learning of skills.

The study reported here will, to some degree, fill this gap of CMC research by examining the learning of the university students' argumentation skills through

their engagement in electronic mail discussions. The skills were measured by analysing the students' outputs after the CMC studies.

Argumentation, reasoning and critical thinking are essential elements in the process of critiquing knowledge and developing one's own opinions. Norris and Ennis, for example, stress that critical thinking is based on reasoning that aims at reflective evaluation and careful grounding of issues under examination. Reasoning and critical thinking, in turn, are closely related to the process of argumentation in which other peoples' standpoints and opinions are critically examined and one's own conclusions drawn on the basis of reasons presented for their support.

In this study the concept of argumentation skills is based on the Toulminian argumentation theory in which an argument is divided into separate components: a claim, grounds, a warrant, a backing, a qualifier and a rebuttal. In addition, there is often a conclusion included in an argument whose function is similar to that of a claim, to reveal the standpoint of the writer. Perkins emphasizes that persons possessing weak argumentation skills most often present only a few grounds in order to support their claims or opinions. In the same vein, Voss and Means stress that persons possessing developed argumentation skills are able to formulate relevant grounds that support the claim and make it believable. In addition, people skilled in argumentation can also formulate clear claims and construct conclusions supported by the grounds.

Computers for teaching argumentation

Computer-based instruction in general

The possibilities of computer-based instruction in the field of teaching argumentation have already been recognized. Computer games, for example, teach practical

reasoning skills, and computer programs can give rapid feedback to students who are practising argumentative writing. Keith *et al.*, developed a program that used an apprenticeship approach for practising argumentation. The essential characteristics of this approach are that students do the activity, that there are valued tasks for students, and that there is a skilled mentor who coaches students in the activities relating to argumentation.

In general, Keith *et al.*, find that computer-based instruction has several features appropriate for teaching argumentation: when using computers it is easy to disseminate learning materials, teaching is flexible in terms of the pace and location of learning, and activities enable students' self-reflection on their own performance.

CMC for teaching argumentation

In addition to those features mentioned by Keith *et al.*, the potential of CMC in practising argumentation, is largely based on the possibility it offers for creating effective interactions between learners. This feature is most beneficial in practising informal argumentation in which arguments are presented in order to assure the audience of the correctness of one's standpoint

CMC has already been applied in fostering informal argumentation and critical thinking. Clark organized an electronic debate through electronic mail between two classes at the elementary school level. In a college-level experiment carried out by Charlton critical thinking skills were practised through discussions at electronic bulletin boards, and Pugh reported on a higher education course in which argumentation was practised through electronic conferencing.

Steinberg stresses that the key feature of CMC in respect of practising argumentation and critical thinking is the focused discussion of alternative points of view

between participants. Many reasons are given to support this use of CMC; some of these are presented below.

First, it has been characterized as a democratic medium enabling participation of all the members on an equal basis. Equality, it is alleged, is promoted because the learning environment is free from some of the features typical of face-to-face settings that may inhibit the discussion, for example, gender, age, ethnicity, occupational status or performance skills. In addition, socially shy persons and those who need time to construct their ideas can, it is claimed, participate in CMC discussions on a democratic basis. Equal and democratic opportunities are important aspects for argumentation as they enable the discussants to concentrate on matters of fact free from many factors that may make it difficult to exchange opinions together. For instance, Boyd links the equality feature of CMC with argumentation by emphasizing its suitability in providing emancipative educational learning situations in which argumentative dialogues can be carried out free from rhetorical tricks and threats or promises typical in ordinary face-to-face debates. Thus, by electronic discussions it is possible to establish such an equal learning environment in which the responses are directed rather towards the writer's thoughts instead of the writer as a person.

Second, studying through CMC consists of text-based contributions to the topics under consideration. As Henri puts it, written text demands exactness' careful consideration, and explicit expression of thoughts. These criteria play a fundamental role in argumentative dialogues and debates because the goal of the activities is to assess the strengths and weaknesses of others' contributions. In addition, when using CMC there is an opportunity to reread one's own and other people's

texts before any revisions of ideas are carried out. However, CMC may also produce interaction which does not, necessarily, always act as an advantage when practising argumentation. Tella, for example, found that texts presented during computer conferencing were not always exact and well considered, instead they included a lot of fragmentary and disconnected sentences usually met in colloquial use of language. These features of language do not belong to academic argumentative discussions in which, rather, the content and style of contributions should be carefully considered and formulated. Anyway, it depends largely on the stated aims and tasks of the particular CMC-course whether the interaction is well thought out and argumentative or similar to conversational language.

Third, the asynchronous nature of CMC interaction makes it possible to participate without restrictions of time and place. To have enough time is important, for example, in a debate when a person wants to construct valid reasons in order to support his/her opinions with special care. In addition, when people can log on at any time they want they can make use of resource materials, books, newspapers, notes, etc., in preparing their contributions to discussions. By the same token, the asynchronous mode of interaction may also be a disadvantage, since it is possible that one gets feedback to his/her contribution too late or, as in the worst case, the contribution may never be commented on.

Fourth, perhaps the most unique feature of CMC is the possibility for group communication and many to-many discussions. Through this kind of interaction participants may make use of each other's ideas and thoughts. This is important in argumentative discussions in which the main purpose is to find out many relevant points of view and, thus, create alternative approaches to issues examined.

In the present study electronic mail was applied in the field of university level social studies and education. Typical of these particular disciplines is that only seldom is there one correct answer to the issues confronted. Rather, many social and educational issues often have several dimensions and many alternative approaches to analysis. This multidimensional nature of topics offers many possibilities for argumentation.

The two basic research questions that were studied in this project were: (1) to what extent is it possible to promote students' argumentation skills through the use of e-mail? and (2) which is the more appropriate way to practise argumentation in an e-mail environment, a tutor-led seminar mode or a student-led discussion mode?

Method

Subjects and design

The subjects of the study consisted of students ($n = 224$) taking an MEd level introductory course in the sociology of education at the Department of Education in the University of Jyaskyala, Finland, during the autumn term 1990. The main criterion for the selection of this particular course of sociology of education was that the books included in the course contained issues with divided opinions and, hence, were suitable for argumentation and debates. Issues of this kind were, for example, 'the hidden curriculum in school' and 'sex roles in school'

Four e-mail groups were established: two groups engaged in the seminar mode and two groups in the discussion mode of e-mail study. Participants in the four groups, eight students in each, were recruited on a voluntary basis. Two tutors were also employed. Since one student dropped out, 31 e-mail students completed the course. The remaining 193 students formed a

comparison group and they engaged in the traditional self-study at the same time. The e-mail studies consisted of practising argumentation and, thus, acted as an experimental treatment. The students in the e-mail groups and in the self-study group were given a post-test in order to measure the level of the argumentation skills after the e-mail experiment. The design employed can be called a quasi-experimental static-group comparison design

Answers to the research questions were sought by comparing the post-test results between different groups. The first question was addressed by comparing the results of all the e-mail students with those engaged in the self-study, and question two by comparing the results of the students engaged in the seminar mode of e-mail study with those engaged in the discussion mode.

Because the formation of the research groups was not based on randomization it is necessary to examine the distribution of the subjects in the e-mail groups and in the self-study group in the light of some relevant background variables. This is important because the irregular distribution of relevant variables in different groups may have distorted the results. Variables examined were age and study experience, which Voss and Means have found to be linked with the argumentation skills, and gender.

Teaching arrangements

General aspects of the e-mail studies

The software used in organizing the e-mail experiment was an ordinary electronic mail (Elm) for UNIX including a text editor named Emacs. Elm was equipped with a mailing list containing the addresses of all the participants of the conference. Hence, the program delivered the messages sent in one group to the other

students and the tutor in that particular group, thus enabling the students to engage in many-to-many communication within their own study group.

During the six-week studies the students wrote texts relating to the topics addressed in the set books and lectures. Studying was interactive in nature: the students' texts consisted of their own ideas and thoughts as well as comments relating to the other students' texts. The participants were supposed to write at least two messages a week in order to pass the course and earn the credit.

The e-mail students did not know each other personally before the experiment, and they also had the possibility to remain anonymous during the studies. Only the organizers knew the students' real names. A single face-to-face session was held prior to the experiment in order to get the students familiar with the use of the computer terminals and the mailing program.

The main contrast between the different modes of e-mail study was that in the discussion mode the discussion topics were selected by the students together while, in contrast, in the seminar mode they were chosen by the tutor. In addition, the tutor's general role in the seminar mode resembled that of a teacher and a leader but in the discussion mode, that of a coworker and resource person.

Practising argumentation during the e-mail studies

The didactic content of the e-mail studies was argumentation itself. A short literature review on argumentation was posted to students and tutors before the studies in order to acquaint the participants with the concept and procedural structure of argumentation. Hence, the review acted as a helping aid for the students when formulating their messages.

Studying in the experiment consisted of the students' argumentative contributions related to the topics addressed in the set books and lectures. During the studies the students were directed to present in their texts a lot of their own opinions and points of view related to the discussion topics as well as to critique the other students' opinions and standpoints. In addition, the students were directed to defend themselves by presenting counter-arguments when critiqued by other students.

The aim of the studies was to create a collaborative learning environment in which the students are engaged in a constructive dialogue and debate. Hence, they were offered an opportunity to make use of the peer students' opinions and alternative approaches to topics under examination. Furthermore, special attention was paid to grounding by asking the students to present carefully considered reasons in order to support all their opinions and critical comments.

Data collection and analysis

The course in question consisted of three set books and a series of lectures. The data of this study were based on exam tasks relating to two of the books. Broady's book was obligatory to everyone while Takata's book was optional with the third one. Hence, all of the 224 students answered the tasks relating to Broady's book and a subset of 134 subjects the tasks relating to Takata's book. The end-of-course examination included tasks relating to: (a) subject contents; and (b) argumentation skills, from which the latter ones compose the data of this study.

Argumentation skills were measured with four tasks. Two of the tasks focused on the analysis of argumentative text. The researcher composed the tasks by selecting two argumentative text passages, one from

Broady's book (task 1) and the other from Takata's book (task 2). The students were then asked to identify from both of the texts: the main claim (claims 1 and 2) and the grounds that supported the claim (groundings 1 and 2). They were then required to draw their own conclusion based on the groundings (conclusions 1 and 2).

The other two of the four tasks focused on the composition of one's own arguments. They were composed by giving the students one central theme from both Broady's book (task 3) and Takata's book (task 4). The students were then asked to compose their own claims relating to the themes (claims 3 and 4) and the grounds to support their claims (groundings 3 and 4). A more detailed description of the data collection is presented in Marttunen.

The analyses focused on the argumentation skills of the students: the students' skills in formulating the claims, the grounds and the conclusions. The reliability of the analysis turned out to be fairly high. It was examined by having two people classify 20 cases independently. The reliability coefficients of the variables relating to the claims varied from .69 to 1.00, to the grounds from .43 to .76, and to the conclusions from .50 to .77.

Analysis of the data relating to the skills in formulating claims

Two variables were formed on the basis of the analyses of the claims 1 to 4). The first variable, Clearness (SI), examined whether the students possessed a skill to formulate clear claims. It was formed by summing the scores of the 12 item variables relating to the four claims. The item variables focused on whether a claim: (a) included a contention (variables X1 to X4); (b) focused on one contention (variables X5 to X8), and (c) was understandable (variables X9 to X12). All these item

variables were dichotomous in nature and the simple matching similarity ratio (SM ratio) between them varied from .57 to .99. The second variable, Substance (S2), was formed by summing the scores of item variables X 13 and X 14 (SM ratio .52), which focused on whether the claims identified by the students from the texts corresponded to the fundamental claims of the authors in the texts.

Analysis of the data relating to the grounding skills

The grounds were analysed by four variables (X 15 to X18) named 'Accuracy' indicating the students' skills in formulating accurate grounds. Two of the variables were based on the grounds the students had to identify from the texts (groundings 1 and 2), and two on the grounds they were asked to compose by themselves to support their claim (groundings 3 to 4). No aggregated variables were formed since the intercorrelations of the variables were low.

A person was considered to have presented accurate grounds when he/she had provided relevant evidence which provided a wide scope of support to the claim. By contrast, when the grounding was deemed inaccurate it included only a few and often irrelevant grounds.

Analysis of the data relating to the skills in formulating conclusions

The analysis of the conclusions was based on tasks 1 and 2, in which the students were asked to examine the two text passages by identifying the claim and the grounds from the texts and to draw a conclusion based on the grounds. The analysis focused on the relation of the conclusion to the grounds and to the claim.

In the analysis of the relation of the conclusion to the grounds the focus was on the justification of the conclusion (i.e., whether it was supported by the grounds). Two item variables (X19, X20), based on

conclusions 1 and 2, were formed (SM ratio .66). Their scores were aggregated to form a new variable, Justification (S3), which describes the students' skill in drawing justified conclusions.

When the focus of the analysis was on the relation of the conclusion to the claim the consistency of an argument was examined. The argument consisted of the claim, the grounds and the conclusion the students had composed. Since a claim consists of a conclusion, an argument in which the conclusion was identical or parallel to the claim was interpreted as consistent, and an argument in which the claim and conclusion differed from each other, as inconsistent. Item variables X21 and X22 (Pearson Product Moment Correlation.3 1, $p = .000$) were aggregated to form a new variable, Consistency (S4). This indicated whether the students possessed the skills needed to compose conclusions manifesting the consistency of an argument. The details of the analyses are described in Marttunen.

Results

The results reported in Tables 2, 3 and 4 relate to the students' skills in formulating the claims, the grounds and the conclusions. Two kinds of comparison were made. First, the results were compared between the students engaged in different modes of study, and second between the students engaged in different modes of e-mail study. The differences of the means were examined by a t-test. The general level of the university students' argumentation skills and its implications have been reported elsewhere.

Skills in formulating claims

According to the results in Table 2, the means of both variables proved similar among the students engaged in the e-mail study and in the self-study. A comparison

between the different modes of e-mail study show that the students engaged in the discussion mode were more skilled in identifying an essential claim from the text (Substance, $p = .050$) than their counterparts engaged in the seminar mode.

Grounding skills

Table 3 shows that in the case of Broady's book the means of the students in the e-mail study were higher in both variables (X 15, X 16) than the means of the students engaged in the self-study. When the task was to analyse a text passage (X 15) the difference was also statistically significant ($p = .025$). Among the different modes of e-mail study the results show higher scores for the students engaged in the discussion mode in both variables, although the differences were not statistically significant.

The results relating to Takala's book show, in contrast to Broady's book, higher means among the students engaged in self-study compared to the e-mail study in both variables (X 17, X 18). Furthermore, when the task was to compose their own argument (X18) the difference was statistically significant ($p = .026$). The results relating to the different modes of e-mail study are, however, accordant with the results of Broady's book indicating differences, although not statistically significant ones, in favour of the students engaged in the discussion mode.

Skills in formulating conclusions

The results in Table 4 indicate the better skill of the e-mail students in formulating conclusions manifesting the consistency of an argument compared to the students engaged in the self-study mode (S4, $p = .008$). The means of the variable relating to the students' skill in formulating justified conclusions (S3) were almost the

same. Among the e-mail students the means of the students in the discussion mode were, again, higher in both variables although not in terms of a statistical significance.

Discussion

The results indicate better argumentation skills among the e-mail students compared to those engaged in the traditional self-study mode. Furthermore, the results showing the e-mail students' better skills in formulating the conclusions in a manner that manifests the consistency of an argument support this conclusion.

Hence, the findings suggest that it is possible to promote students' argumentation skills through e-mail study. This inference is also supported by earlier results related to the same project, as well as by the results suggesting the general suitability of computer software for practising argumentation. Although the results also show other differences between the examined groups, the results varied in accordance with the exam book in question, and hence, they do not permit any far-reaching inferences.

In addition, the results suggest that the student-led discussion mode of e-mail study is a more appropriate way for practising argumentation compared to the tutor-led seminar mode. This finding is indicated by the higher means of most of the variables measuring argumentation skills among the students in the discussion mode compared to the students using the seminar mode. The earlier findings of the same project report the same trend. The results are consistent also with previous studies reporting on CMC's convenience for student-led discussions and self-directed learning.

The limitations of these results can be anchored in two points. The first limitation is related to the design of

the Study. Although inferences concerning cause effect relations are made, the design of the study was quasi-experimental, lacking the randomization of the Subjects. A threat of this shortcoming is that the post-test differences between the groups can be attributed to characteristics of the groups as well as to the experimental treatment. In this particular study the results may have been affected by variables essential in terms of argumentation due to their uneven distribution in the examined groups. To control this problem the Pearson Product Moment Correlations of age, study experience and gender, with the variables measuring argumentation skills, were examined. The correlations varied from .18 to .16. Because of the low correlations, the likelihood that the lack of the randomization has distorted the results is low.

In addition, the formation of the e-mail study groups on a voluntary basis may have resulted in differences between the e-mail groups and the self-study group. The correlations between voluntariness and the variables of argumentation skills varied from $-.09$ to $.35$. It is possible that the students in the e-mail groups were more motivated for debating and exchanging opinions than their counterparts in the self-study group, and thus, more skilled in argumentation as well. Consequently, it is worth questioning whether the differences existed already before the conference. The question could have been answered by administering a pretest to the students, but there were two reasons for not using this procedure. First, the study was a field study in which the measurements acted as a natural part of the studies, and hence, the organization of a pretest would have led to practical problems in gaining student cooperation. Second, since the use of a pretest often leads to a test-wise problem, the advantage of using it may not

always be taken for granted. A test-wise problem means that the students may show an improvement simply as an effect of their experience with the pretest. Consequently, using a pretest might have produced more problems than benefits to the study.

The second limitation of the results lies in the question of whether it is possible to develop any cognitive skills during the short time of six weeks. This question is relevant according to Pascarella who suggests that rather than any particular experience, it is the students' engagement in the intellectual and social experience of college that promotes critical thinking skills. Nevertheless, short interventions and especially CIVIC ones have proved feasible when practising argumentation. Hence, it is legitimate to assume that there has been some progress in the students' argumentation skills due to the experiment, although a longer practising period would have been more appropriate in terms of evaluating the possibilities of CIVIC to promote these skills.

In terms of the reliability and validity of the measurements and analyses, it can be noted, for one, that the data analysis proved reliable, which gives further support to the results. For another, in terms of the external validity of the study it is important to notice that although the study was carried out in an on-campus setting there are no reasons why the teaching arrangements could not be applied also in a distance education setting. Hence, the results as well as the other experiences of the study can be generalized to distance education too.

The examination of the internal validity of the results concerning argumentation is complicated because of the many-dimensional nature of the phenomenon. This complication was shown also by the partial discrepancy

of the present results: the findings indicated better grounding skills of the e-mail groups in the tasks on Broady's book but, in contrast, better results among the self-study group when the tasks were related to Takala's book. Consequently, this discrepancy may be a sign of either the low validity of the study or the complex nature of the phenomenon. In addition, it may be a sign of the inconsistency of the people in their argumentation skill performance. However, the results suggest a consistent superiority of the discussion groups over the seminar groups. This can be taken as a sign of the good internal validity of the measurement instrument indicating that the questions have been focusing on the same issue. In sum, the high reliability of the analysis as well as the examination of the measurement's validity aspects suggest that the results are reliable.

When studying the findings from a broader educational point of view it is interesting to note the superiority of the student-led mode over the tutor-led mode of e-mail study. In this respect, the results lend support to the current andragogical approach to adult education. The results showing higher scores among groups in which the tutor's role was supportive, not directive, favour the andragogical emphasis of the teacher's role as a co-learner and a facilitator of the learning, in contrast to the teacher's traditional role as a deliverer of knowledge. Moreover, andragogical theory suggests that the adult students' self-concept includes the need of being responsible for their own decisions, the need to know why they learn, and the need to be self-directing. The better achievements among students engaged in the discussion mode of e-mail highlighted the students' self-direction and their own decision-making. Hence, these findings support the andragogical assumptions of adult learners: the results revealed that

students are able to be self-directive and responsible enough to take care of their own studies if only the chance is offered to them.

Finally, the present study indicates the potential of CMC targeting at improving the argumentation and critical thinking skills. In addition, the democratic nature, the text-based interaction, the asynchronous mode of communication and the possibility of many to-many communication can be assumed as beneficial characteristics of CMC in terms of practising these skills needed in an academic context. In fact, skills of making well-supported choices and assessments between a variety of alternatives as well as of being critical towards knowledge and of being able to select the relevant knowledge one needs are skills of a great importance in managing in the modern information society. It is our belief that argumentation and critical thinking skills should be practised by young children before they enter university, and so experiments relating to CMC should be conducted at lower educational levels too. Providing many-sided information on CMC to educators would help them make use of the large potential of e-mail-based interaction, especially in the field of argumentation and critical thinking.

Online Lectures

The 1960s saw a massive growth in the application of computers that inspired much optimism in those who believed that computers would revolutionize the teaching and learning process. For example, Sutherland and Johnson both demonstrated that it was possible to draw interactively on a cathode-ray tube (CRT) and Katzenelson showed that a circuit diagram so drawn could be correctly interpreted and analysed. Schwartz and Taylor showed the educational value of simulating a rocket travelling at a speed significantly close to that of light. Their visual demonstration showed roadside telephone poles not only bending backwards down the road, but the L-shaped crosspieces rotated. Their simulation enabled students to 'focus on the phenomena without being burdened by the constant onslaught of mathematical symbols'. The rotation effect was not appreciated for more than fifty years after relativity had been described, suggesting that the mathematics continued to obscure the effect from all those who otherwise appreciated relativity. General purpose systems upon which courseware was produced were far from being simply keyboard-orientated, designed only for text-based drill and practice. The IBM 1500 Instructional System with its conventional television CRT refreshed from disk, a light pen for interaction, and a separate image projector, allowed for text and graphics to be displayed and manipulated. The PLATO system adopted

a plasma panel display ; it had the ability to overlay a projected image with computer generated material, and had an audio capability. Either a lightpen or an overlaid touch panel facilitated student interaction.

Davis implied that in the long term the class room would be more capital intensive and that it would become less labour intensive. While this might be so in the class room, it certainly does not apply to the preparation time. For example Oliver and Brooks reported a preparation time of four hours for each one hour of class room activity; most of the teaching was talk and chalk but was supplemented by on-line demonstrations. Clarke refers to a CDROM based program that replaced twenty lectures, twelve hours of practicals and ten hours of workshops. He estimated that the project took five person-years to complete. Sugarman reports a development to delivery time ratio of 50: 1, and more recently Marshall *et al.*, report ratios of '800: 1 and beyond' for multimedia courseware. It is not clear how many hours of lectures are replaced by the one hour on-line, nor is it clear whether the development time includes the gathering and organizing of material that would have to be done irrespective of the medium of presentation. Furthermore, it is not clear whether the development time includes a maintenance element for corrections and the insertion of additional supporting material. But for University staff the prospect of devoting so much time to generating courseware is unattractive and cannot be regarded as cost-effective. From an institutional point of view it would be unwise to commit wholeheartedly to teaching by computer because of the enormous fall in research income and output that would necessarily be incurred. While in principle courseware can be shared among institutions, the time required to appraise a number of pieces of courseware will be very much greater than appraising the course text book,

particularly if the courseware is (dis)organized in a spaghetti-like web. If lecturers do not prepare for a live presentation, their ability to answer the difficult questions from students will be weakened. Furthermore, if lecturers cease to determine the content of their courses, they lose their professional claim. But perhaps the most important reason for lecturers determining content is that it leads to university courses that are unique and provides students with choice. Nevertheless, the incorporation of some material from elsewhere can save time and certainly should not be discouraged.

Authoring skills

Although lecturers may be computer literate with word processor skills, they cannot be expected to have the knowledge or capacity to engineer a good user interface; one that enables students to concentrate on what they are learning rather than on how to manipulate the system. Producing courseware with some of today's authoring systems requires that knowledge and even programming skills. For example, courseware often places an overreliance on hierarchically arranged structures that effectively hide information and allow the act of exploration to become an educationally purposeless activity. Information is often updated in a computer-efficient manner; the resultant movement leaving students cued to the wrong place on the screen. Having to think about relocating their focus of attention interferes with what they are learning. There is a temptation for the lecturer-developer to include multiple paths along which students can travel by pointing-and-clicking, leaving the students in danger of losing the focus of their learning objective. Indeed what is actually required is support for a personal discovery of insight, not the chance discovery of already publicly known facts. Widely available development environments actually leave authors open to more

bewildering design considerations than did previous generations of authoring systems. So one approach is to form teams consisting of the lecturer, an educationalist, a programmer, and a user-interface designer; an expensive approach that has been found to be unattractive to educational institutions.

Metaphorical-based learning

Students should not be regarded as pots into which facts and concepts are poured without it being necessary for them to embark on any cognitive reorganization and conflict satisfaction. Students have achieved successful learning outcomes by attending lectures, reading text books, and then personally consolidating the material. If information technology is to be exploited then one of its main contributions should be to speed up the learning process. This can be simply achieved by removing the tedious impediments to learning such as note-taking errors and repetitious clerical activity, and ensuring that concepts are explicitly described and illustrated. If lecturers are to be encouraged to exploit information technology then preparation time ought to be of the same order as for 'talk and chalk' lectures and problem classes and achieve the same level of quality as they do without IT. But exploiting the computer should provide an upgrade path to higher quality in the learning experience. The authorware must allow lecturers to concentrate on their specialities and not on the design of the navigational interface. They must see that they can withdraw from the process without loss of time. So an alternative proposal is to base courseware development on familiar metaphorical paradigms.

Lecture-based learning

The material conveyed in a lecture is more thoroughly covered in text books, but the lecture conveys the material in a more easily digestible form, preparing the

mind for the more complete coverage in the book. While the lecture theatre is not the place where most of the learning takes place, its prominence in the learning process has stood the test of time. Students overwhelmingly demand the retention of live lectures. Lectures offer a framework that identifies the scope of the material. They lubricate the learning process that takes place later during private study when the material is consolidated. Lectures structure the working day, provide social contact and interaction, and an opportunity for students to interrogate a human expert.

Metaphorical basis for the user-inference

The metaphor on which the system described in this paper is based, is that of the conventional lecture presentation, a situation familiar to university lecturers. It provides in one place on the screen the integration of text, diagrams, animation, illustrative pictures and video material, all sequenced and synchronized with a spoken narrative into a linear presentation. This compares favourably with the live-lecture situation in which projector foils, 35mm slides, video and audio are all controlled by different pieces of equipment and displayed possibly in different parts of the lecture theatre. The metaphor used for both the creation and presentation of each lecture is that of an electronic book whose content can be roamed in much the same way as with a real book even down to experiencing the same page turning cues that are inherent in real books. Students may have the whole lecture played in sequence (stopping where necessary); they may truly browse to any slide and have it 'played' through, or see/hear a fragment of the sequence. Thus students can passively experience the lecture, or navigate nonlinearly around it. Links to external material such as supportive technical papers held locally or on the World Wide Web can be

incorporated together with additional notes below the slides.

A visual programming method is used throughout to specify both the content of the slides and the dynamics of the presentation. This method is based upon a schematic drawing paradigm. It might be useful to regard this as a fifth authoring paradigm alongside those of structure, time-line, flowchart and script as identified by Hardman and Bulterman. While there is some resemblance to the flowcharts approach, the flow lines are absent, the sequence is determined instead by the relative position of symbols, and the flowchart is placed on the slide rather than have the slide content accessible through the flowcharts. In some ways the emphasis is on fitting the dialogue to the picture rather than fitting a picture to the dialogue; though of course a presentation should be prepared using an iterative process and the system allows for this.

The Book Emulator

The Book Emulator presents a book-like user interface to information enabling that information to be truly browsed by flicking through the pages of an electronic book. The page turn is animated, indicating directional travel, and the splayed page images down the sides of the book change size according to the user's position within the information space. Two mouse buttons provide for forward and backward travel, while the third button enables selection.

A number of central services are provided through the utensils located above the book including word and symbol searching, proper bookmarks, inter-book hyperlinking, and an import gateway for external links to arbitrary fragments of information.

The Book Emulator has a schematic drawing

capability based upon symbols that are interconnected by lines and annotated with text. When a symbol is selected it is attached to the mouse cursor and can be relocated on that page, moved to any other page within the book, or moved to any other book that is also open on the screen. A grouping facility automatically groups lines, text and other symbols that are contained within a symbol. The last item or group selected is remembered through the 'glue-pot' and its content is available in any other book on the screen that has a glue-pot. The utensils located above the book provide for the moving and copying of complete diagrams and, of course, when attached to the mouse cursor these may be dragged to any other page within the book or to any other book. Symbols, text, lines, groups, whole drawings may be deleted by selecting and tacking outside the confines of the book. Symbols and fonts are usually selected from library books containing such collections.

Two function keys are provided to speed up drawing. If either is pressed when nothing is attached to the cursor, then what is in the glue-pot is attached to the cursor. This enables the fast repetition of a symbol in a drawing without the need for a large movement of the mouse cursor up to the glue-pot. If a symbol is attached to the cursor then pressing the function key causes it to be changed to a related symbol if one exists. In this way, for example, having selected a transistor symbol, the different orientations of the transistor are quickly available to the user. The two function keys cause the changes to go opposite ways around the 'ring' of related symbols. If a string of text is selected, then the appearance of the string is changed when the function keys are pressed. For example, the text might be made bold, italic, underlined, squeezed, outlined and so on. If a line is attached to the cursor when the function keys are pressed, the line appearance changes to dotted, dashed,

and so on. User-authored links to external fragments such as audio, pictures, movies and other books are available through special symbols which act as anchors. Their manipulation is identical to any other symbol, so may be moved within and between books, be grouped, and be changed with the two function keys. However, when they are 'long selected' their content is displayed or heard.

The central system (OHP)

The central system is fronted by a book that provides for up to two library books to be open at any one time including a library book maintained by the user for collecting often used symbols, text strings, or privately created symbols (pictures). Up to twenty slides per book can be created. Through this interface the lecturer can create paper-based booklets of slides for students (one slide per page with room for personal notes, or two slides per page). In addition another booklet can be created, this time with the slide followed by a blank story-board table all on the same page. The lecturer can also create a set of slides, one per page, for transfer on to view-foils or 35mm slides.

Two electronic hardcopies are available. One creates a HTML file suitable for a Netscape type viewer, while the other creates a HTML compatible file that has additional tokens. This enhanced HTML file is automatically passed through a separate converter that creates a book version of the electronic slides. One of these additional tokens forces information to begin on a new page and another enables dynamic instructions to be passed through. These dynamic instructions are required for animation and the sequential spoken narrative; facilities that are not available through viewers such as Netscape. Creating this added complexity means that on-line lectures displayed through the Book Emulator

could be transmitted over the World Wide Web for final viewing through the Book Emulator.

Visual programming of slide context and lecture specification

Creating on-line slides

The creation of on-line slides exploits the schematic paste-up facilities of the Book Emulator. It is arguably no slower than any other method of slide creation including those written by hand. Lecturers need go no further than this to have benefited from using the system and, like other systems, slides can be edited.

Creating on-line lectures

The minimum requirement for changing on-line slides into on-line lectures is to provide a spoken narrative and the sequencing of that narrative is visually programmed with the same schematic paste-up facilities as are used to create the slide content.

The audio fragments are usually of thirty to sixty seconds duration (one to four sentences) and are captured on to the local fileserver using a separate audio capture tool. With a single command, the speech fragments are imported into the Book Emulator's in-tray, that is located above the book. From there, their link symbols (anchors) are extracted and placed in position on the slide. They are sequenced according to a left-to-right, top-to-bottom rule that has a degree of tolerance which enables the correct sequence to be interpreted without the need for exact alignment. By default the command that sends the anchor to the in-tray assumes that an audio file contains speech and chooses one of the speech symbols (the speech bubble). Using the function keys this symbol can be changed by the user to identify it as music.

As well as showing the whole slide all the time, some lecturers like to reveal material gradually as they progress through the slide. Others prefer to point to the

bullet point currently being discussed. To specify what has to be revealed or indicated at any point in the sequence, the slide must be partitioned with 'rule-off' symbols. Then any speech fragment between rule-offs is sequenced after the revelation or identification has taken place. In this way the lecturer can specify what is to be revealed and what has to be said after that revelation. There is one 'rule-off' that partitions the slide into two. In the top part, there are two speech fragments (shown as speech bubbles) and there is one speech fragment in the lower part. A link to an external document is specified below the last speech bubble. The Notes-Jot anchor leads to the 'I additional notes' that are placed below the fragment access buttons. Behind the specification book is the library book that contains the special symbols needed in the specification. This book also contains, on other pages, some fonts suitable for OHP production and general block diagram symbols.

It is important to 'top and tail' a lecture; that is to begin by defining the scope of the lecture, describing the benefits that will accrue from understanding the information, and reminding the students what they should know as preparation for what is to come. At the end they need to repeat that information, emphasizing how the new knowledge can be used. In consequence, it may be useful for the lecturer to show briefly some of the key slides and this can be incorporated in the sequence with the 'show slide' specification symbol.

Colour pictures and movies can be incorporated in a slide by placing them appropriately in the sequence of specification hyperlinks. These links are imported into the Book Emulator through the in-tray using the same command as for the speech fragments. Colour pictures and movies can be used to illustrate aspects of a lecture (examples of jet aircraft) as well as be central to a lecture (for example, the discussion of a famous painting). In the

latter case and in situations where a set of pictures with accompanying music is needed, it is necessary to specify 'parallel audio' which causes the audio to be played as the pictures are being displayed.

While the revelation/indication mechanism works particularly well for slides containing textual bullet points, it is not satisfactory if a diagram is to be described in which, for example, flow of data needs to be animated or the diagram needs to be built up as the narration progresses. In these circumstances it is necessary for an animation book to be included in which the individual frames of the animation can be specified. This book is the same as that fronting the OHP program. The content of each animation frame is pasted up in the same way as all the other slides and the same specification facilities are also available; but in going from one frame to the next, there is only a short delay imposed, thus enabling animation to be shown in steps (rather than continuous). Only twenty frames are available in the animation book, but animation books can be nested.

Automated creation of on-line lectures

The central software (OHP) generates different HTML files for the World Wide Web browser and the Book Emulator versions of the on-line lectures. For the Book Emulator some additional tokens have been defined to accommodate the notion of pages, enabling each slide to start on a new page. In addition the necessary animation instructions are also passed through so that a lecture can be played. For the World Wide Web version no such dynamics are possible but each fragment of the sequence is made available through a point-and-click button interface as they are in the Book Emulator. It is not really correct to call the World Wide Web version 'on-line lectures' since no lecturing is actually supported.

Overall presentation

The on-line lecture generator goes through each slide visually removing the lecture specification material, leaving only the slide content. The cleaned-up slides are then bitmap dumped, resized appropriately without loss of detail, and if being prepared for the World Wide Web are coloured according to the 'colourway' specification. Such colouring ensures that the slide, background, and button highlights are all colour coordinated. Below each slide the fragments of the lecture sequence are accessible through buttons (also colour coordinated). These buttons are titled: narrative (for speech), picture, movie, document, www link, music, or textbook.

Below the fragment access buttons, additional notes may be included. These notes are created with an editor (changed using the function keys) and are converted into HTML. HTML tokens may also be used provided they are recognized by the HTML-to-Book Emulator converter. Among other facilities, words or phrases can be made bold, in-line images may be incorporated, and further hot references may be included.

In the Book Emulator version where the lectures are dynamic, the student can go to the front of the book and select the button that causes the whole lecture to be played through with all the covering-up, revealing, animation, overlaid pictures/movies correctly sequenced with the spoken narrative. The speech can be paused and resumed by pressing the space bar and when resumed it plays the last few seconds again before carrying on. This enables users to orientate themselves before the next part of the information is conveyed. Pressing the backspace key causes a bigger jump backwards in the speech. The complete lecture can be stopped, and then can be resumed by selecting the button at the front of the book, it continues from the start of the slide at which it was stopped.

Alternatively the student can browse (by flicking through the pages) to a particular slide and select it and see it dynamically presented. In either the complete lecture case or the single slide case, the last fragment heard or seen is indicated by greying the appropriate access button below the slide. By the end of the slide, all the access buttons have been greyed and are then restored when the sequence ends. This process indicates which of the access buttons will return the user directly to a specific fragment. Notice that the access button is not greyed while the fragment is heard or seen and then restored when it has finished, because this would attract eye movement away from the slide and its animation.

The Book Emulator allows the student to make personal annotations either directly on to a book or through electronic Post-Its like that used to specify the 'additional notes'. Furthermore, links between individual slides both in and between books can be installed by creating a link to the current slide on display using one of the utensils. The resulting anchor is then selected from the in-tray and taken to the slide where the link is to be made, placing it where it is most appropriate. For an explicit two-way link, the process is repeated the other way round.

All material directly used in a lecture is copied to the same directory, *i.e.*, all documents, pictures and movies are copied in their original form. It is these copies that are displayed when the fragment access buttons are selected. So colour pictures can be seen in their original full size. However, the colour pictures used when playing a slide in the Book Emulator version are scaled to fit exactly the slide area below the running header and these are also created in the directory and in the same format (GIF, JPEG, etc.) as their originals. To fit, it may be necessary to change the aspect ratio from that of the original. But if the picture is too thin, it is only scaled to

fit exactly in either the vertical or horizontal direction, and is then centred in the other direction; the original aspect ratio is thus retained. If the picture is smaller than the slide area, it is centred in the slide and no scaling is applied. During the playing of a slide (Book Emulator only) colour pictures and movies are overlaid on to the slide area so that they are placed where the eyes are focused; it is not necessary for the user to search visually around the screen for the picture or movie.

Audio files are converted to a single channel (mono) and compressed before copying. A delay of one second is imposed between the playing of one fragment and the playing of the next when the sequence is translated into the on-line lecture. If music is immediately followed by speech or vice-versa, then the two fragments are concatenated without a delay between them and the music is faded in and then out. So all the lecturer has to do is provide the music and the narrative and not be concerned with the technical aspects of smoothing the transition between them.

Pauses play a role in supporting either the linking together of topics or their dissociation. When parts of slides are revealed or highlighted, there is a short pause after the last speech fragment and before the next revelation, followed by a long pause between the revelation and the next speech fragment. This timing provides the supportive cue that the information on the same slide is related and not dissociated. When going from one slide to the next, there is a long delay after the last speech bite has finished and before the page is turned; once the page is turned there is a short delay before the speech bite is played. This ensures that the correct dissociation between slides is surreptitiously cued to the user. Preliminary investigation suggests that the long pause is at least twice as long as the short pause,

with the long pause being between two and three seconds.

Revelation in the on-line lecture is presented by clearing the slide and then gradually pasting back the slide. Highlighting is achieved by greying the whole slide except the indicated section. By default the revelation mechanism is generated when rule-offs exist, but can be overruled by the special 'grey and highlight' symbol placed somewhere on the slide so as to specify highlighting. Revelation or highlighting takes place in sequence with the audio narrative so that a visual change does not take place as the narrative is played. Bligh notes that there is some evidence which suggests that people watching television will 'tend to ignore auditory information when auditory and visual information are present'. Thus if a concept were described in parallel with a visual example it is likely that students would concentrate on the illustration, particularly if it were striking, and ignore the underlying concept. So by adopting a sequential policy it encourages the explicit description of concepts before an appropriate illustrative piece of animation or movie clip is shown; this can then be followed by a restatement of the concept. It is technically difficult to ensure synchronization between audio and visual information with a general purpose computer and to expect lecturers to try to achieve synchronization would increase the difficulty in producing the lecture.

However, when the slide has a 'parallel audio' specification the strong sequential approach is diminished. The duration of each picture being displayed is determined by the playing time of the audio fragment and each picture is displayed for an equal amount of time unless a 'wait' specification follows immediately after the picture specification. In this way the music and the picture display times do not have to be accurately

specified by the lecturer. If there is a fragment of music to be played in parallel with a series of pictures, followed by a second fragment of music with another set of pictures, then the second music fragment is not started until the last of the slides for the first fragment have been displayed. In other words audio fragments are always played sequentially and never in parallel.

When the display of pictures is signalled by selecting the appropriate button below the slide, they are displayed in their original size for ninety seconds and then removed from the screen. This ensures that the screen is automatically kept tidy rather than relying on the user laboriously to invoke the window menu, find the exit item and select it.

Writing on-line lectures is similar to that of writing a book in that they are both published, albeit in different forms. They are therefore available for scrutiny by peers. Thus more care is taken in preparing the material, and this must lead to higher quality. Koumi offers some useful guidance for creating educational videos that are attractive to the target audience and this has been interpreted elsewhere specifically for on-line lectures.

The lecturer is advised to script the narrative, breaking it down into speech bites of perhaps one to four sentences such that it contains an atomic piece of information with perhaps some qualification. The lecturer is then advised to record the speech bites away from any background noise such as the cooling fan of a desktop computer. In practice this means recording on audio tape at home. Prior to recording, the narrative needs rehearsal and must be spoken with at least the same flamboyance as that conveyed in a live lecture. Preferably they should be even more flamboyant to counteract the lack of any body language such as gesticulations that would naturally arise at a live presentation. The whole process

is clearly very time consuming and in the author's view is likely to discourage the take-up of on-line lectures. However, it does ensure that the slide can be talked through in an orderly way, that all that needs to be said is captured, and it does provide the cement that is necessary to make the slides properly understood. In this way the additional spoken narrative improves the quality of the 'electronic slides'.

While a similar tedious process may be experienced when incorporating movie clips, the majority of lectures require no such sophistication. However when required to illustrate sequential and temporal activity in a real-world situation (e.g., user-interface design, personnel management, chemical experiment), then its inclusion adds to the quality of the lecture. Movie clips are captured with tools that are external to the system described in this paper.

The view-foil versions of electronic slides are almost guaranteed to be readable from anywhere in the lecture theatre. Their editing is straightforward and thus a course can be easily kept up-to-date. Furthermore, in principle, fragments of material can be shared with other members of staff and tailored by them for their specific student needs. However, it should be noted that a change in voice, even the same lecturer's voice after several months, can be wrongly inferred as a change in topic, or that it is a conflicting view compared with the previous statement. So editing the spoken narrative requires some care. Editing of course amounts to throwing away fragments and recording and inserting replacements. In practice, the author has adopted the inclusion of the scripted narrative as the 'additional notes' that appear in the on-line lecture below the fragment access buttons. This enables students to speed read and also to not have to listen to the author's voice. But there is some evidence that students simply follow the script as the narrative is spoken and

therefore are not focused on the animating slide. It may be that the author needs to change his policy on this matter.

When originally conceived the emphasis was to use information technology in the lecture theatre as well as having exactly the same material available on-line for private study. Students want live lectures. But unless the Institution is prepared to equip lecture theatres with projectors with high resolution and high light output, the resultant presentation would need to be undertaken in a dimly lit lecture theatre with students straining to read the fuzzy lettering on the screen. Using the conventional overhead projection view-foil overcomes these problems. And yet the integration of animation, pictures and movies is a strong motivator to provide the on-line lecture in a form that would enable it to be presented live by the lecturer while signalling step changes just as weather forecasters do on television.

To this end, work is proceeding to provide a third version of the on-line lecture which will be created in the form of a HTML file with embedded Java tokens. This will enable the lecturer to single step forwards and backwards at both the fragment and slide levels without the spoken narrative, as well as be able to play the whole lecture through with the lecturer listening with the students. While the lecture paradigm may be regarded as a straitjacket, it also offers a completely choreographed show with no new skills to learn except that required for a slide projector type control. Unfortunately it appears that the user-interface particularly with regard to timing, cannot be as well controlled as it can be within the Book Emulator and so association/dissociation may well be hindered in the continuous play version. This problem will be heightened when there are delays on the local area network and the speech (which can only be made to run sequentially with the revelation if appropriate delay

estimates are inserted) is still playing when the next part is revealed.

There is also a need to offer students support for fast nonlinear access to specific topics that might be 'buried' in a particular lecture. For example, while students will have a complete lecture on the Quine-McCluskey minimization method, the definition and effect of flip-flop hold-time may be conveyed in a number of different lectures. Furthermore if students were required (prompted by a previous examination question) to explain the different uses of the exclusive-OR gate, then being able to use the gate symbol as the searching entity might be the only way of eliciting the answer without manually going through each lecture book. Thus it is proposed to provide automatically, support for searching that is based on string, symbol and visual browsing techniques, with no further lecturer effort. This facility would become available when the complete set of lectures is finally mounted on the system for student access. This work is progressing, with the search mechanism already in place in the Book Emulator.

If the concept of on-line lectures is vigorously supported within a Department then each lecture course in each year would be available to students. It is envisaged that each course year would be accessed through a Role Controller displaying each course as a book on a bookshelf. Selecting one of these books would take the user to the index/search book for that course as described in the previous paragraph, and from there the student would access individual lectures within that course. At that stage the virtual lecture theatre will have been achieved and any lecture would be available 24 hours a day, repeatable as often as required.

The major additional time consumer (over and above that which would be spent on creating the lecture

material) is the capturing of the spoken narrative. Given that this needs a rehearsal, recording on to audio tape, listening to it on audio tape, recording it on the file-store, listening to it from the file-store, the minimum additional time to provide the narrative is five times the run-time of the on-line lecture. In practice, it is more realistic to expect this ratio to be ten times the final run-time of the lecture and so it probably doubles the 'talk and chalk' preparation time. It is further estimated that an on-line lecture course for either the Book Emulator or the World Wide Web consisting of twenty lectures, each containing twenty slides and no video, will occupy approximately 250M bytes of disk space. The specification will occupy approximately 2G bytes of disk space.

Electronic Course Materials

With the growth in student numbers in higher education, time for tutorials, seminars and supervised small group work has been attenuated, and the lecture to large groups has become the increasingly dominant mode of teaching. Although the lecture is a highly valuable teaching method, it does not promote the active student participation and arguably more effective learning fostered by work in smaller groups. The first section of this chapter considers the teaching and learning aims for a specific set of students on a computing module. This is followed by some guiding educational theory and principles which sets small group work in the context of the learning cycle and highlights its value. This establishes the rationale for using the Internet and World Wide Web (WWW) technology to distribute electronic course materials to complement lectures. The approach reported here involved modifying the previous balance among lectures, practicals and tutorials away from the lectures, and in favour of the other two more active forms of learning experience. This was achieved by making lectures more efficient vehicles for introducing concepts, which in turn freed up time that was reallocated to tutorial and practical work. The net effect of this evolutionary approach has been to reverse the drift towards lectures and away from tutorials. In the evaluation section evidence for the educational effectiveness of this approach is discussed.

Teaching and learning : Context and aims

There is no one right way to teach in higher education. Approaches must vary by student and subject, and while computer-networked support seems desirable as a way to overcome the difficulties of coping with increased staff/student ratios and reduced resources, educational issues must come first, and the technological responses second. Caution must also be used in adopting any new technology or approach in education. The history of educational technology is littered with the high hopes and limited success of radio, film, TV, video, teaching machines, stand-alone computers and CD-ROM. If the facilities offered by computer networking and the still developing WWW are to fare better in the educational context than its predecessors, it must be closely integrated with tried and tested conventional teaching methods, and viewed neither as a panacea nor as a bolt-on extra. This point is clearly articulated for computer-assisted learning (CAL) by Tickner who suggests: 'The most important factor in the successful implementation and student uptake of CAL in HE is thorough, planned and supported integration with more traditional teaching media'. It is flawed to think that if the delivery mechanism for information is correctly designed then people will learn. Knowledge is not information but an emergent property -knowledge is a dynamic process, a vibrant, living thing, resting on shared assumptions, beliefs, complex perceptions... and the ability to 'go beyond the information given'. In higher education the aim must be to develop students' critical faculties, understanding and independence of thought, and this implies much more than simply employing an alternative medium for the distribution of teaching materials.

Any teaching approach must match the needs and capabilities of a particular category of students and the

course content. The students involved in the work reported here were final year undergraduate students, who had completed two taught years on a BSc in Computing and Information Systems and one year on industrial placement. The students were accustomed to accessing files over a Novell network, and most were familiar with the WWW, though not all had used file transfer protocol (ftp). The module involved was on Human-Computer Interaction, in which students can benefit greatly from exposure to a wide range of user interfaces. It also has a higher visual component than most other topics in computing. The subject area at this level has a rapidly changing knowledge base - perhaps around 10% needs to be revised each year, particularly the examples of best practice.

The teaching context also contributes to the appropriateness or otherwise of a teaching and learning strategy. The University of Ulster has adopted a fully semesterised teaching year. These final year students take 3 modules in the space of 12 teaching weeks, with an allocation of five hours per week for lectures, tutorials and supervised practical work. Even a brief absence can mean missing a significant portion of a course. However, making course materials readily available by means of a computer can partially compensate for this problem. Over the last decade student numbers have increased year after year, so that this final year option now attracts some 45 students. Computer network and laboratory facilities available to computing students are adequate in quantity and excellent in quality.

The primary teaching and learning aim was to facilitate more 'deep' learning. In the hierarchy of the cognitive domain, lectures are appropriate for conveying 'surface' learning, in the form of knowledge, manipulation and application. This is essentially knowledge which can be made objective, formal and

explicit and directly accessible. For 'deep' learning, where the student applies analysis, attempts synthesis of concepts and evaluates what has been done, largely subjective and tacit knowledge is involved and this comes through experience and dialogue, and therefore is supported best in tutorials, practicals and other forms of group work.

The secondary educational aim was to provide more support for different learning styles. That individuals differ in the way they process, absorb and remember information is well-established. There are various categorizations of learning styles. Some students like to have information presented in a step-by-step, cumulative, sequential manner that develops the concept. Others learn best when they are first presented with the general concept and then the details. Some prefer to work cooperatively while others prefer independence. There is also some evidence that female students have a marked preference for face-to-face communication. Although it may not be possible to accommodate everyone's style of learning, the provision of a variety of course materials (electronic and conventional) will go some way to enabling individuals to employ their own preferred learning style.

Some guiding theory and principles

Development of electronic teaching resources is relatively recent, and the rate of technological change so rapid that there is little theory and limited practical experience to build on. One recent attempt by Mayes presents a high level model of the learning cycle which provides useful theoretical perspectives and guiding principles.

Information presentation starts the conceptualisation phase. Subsequently, concepts are iteratively refined, understood and internalized by action—applying the knowledge in performing meaningful tasks, such as in

practicals, assignments or projects. Mayes argues strongly that 'Dialogue is fundamental to education. It is, of course, possible to learn without discussion, but the need to support deep learning through tutorial and peer-group dialogue is paramount'. The lecture is an efficient and cost-effective way of communicating knowledge, but on its own it promotes surface learning and does not provide the appropriate context for deep learning. This form of provision may also tend to promote relatively passive learning strategies focused on memorization and inhibiting the development of decision-making skills.

The most conventional forms of dialogue in higher education include one-to-one discussion, tutorials, seminars, peer group working and written feedback on assignments. Indeed, it has been claimed that appropriate assessment and feedback are the most effective differentiator between the best and worst courses. Students need to be able to ask questions to correct misconceptions. It is important to get them working together, to share insights and identify common confusions. Presenting students with information in some form and through some medium, while a necessary step, is by no means sufficient to define an effective teaching and learning strategy. Viewed from this perspective, learning is a by-product of understanding, where understanding occurs best through performing tasks, and reflecting on them alone and with others.

While excellent on-line material, perhaps produced by a well-resourced team of subject, pedagogic and presentation experts can greatly reduce the need for live lectures, the economic forces in the UK university sector are pulling in the opposite direction. Although some nationally funded courseware is beginning to show that such an approach can be applied successfully in the earlier years of university teaching, where course content changes relatively slowly and is targeted at large

numbers, it is much less applicable to final year undergraduate or postgraduate courses, here content changes more rapidly, and where separate modules are taught to fewer students. Moreover, the live lecture is not only highly effective for explaining concepts, but can also motivate and convey enthusiasm, and with it an appreciation of the value of the subject, set learning goals, add humour and asides, provide a developing overview of information, point to resources, keep students to at least a minimal reading and practical schedule and provide a social setting. So the lecture has many advantages, and, of course, represents no additional costs to the educational institution. In moving to increased levels of electronic support, retention of lectures also reduces any risk to the education quality or to the students' examination chances.

The revised teaching and learning approach

Rebalancing the Human-Computer Interaction module took the form of reducing the time devoted to lectures (from a previous 4 hours to 3 hours per week), maintaining the supervised practical content (at one hour, with existing demonstrator help but through on-line support increasing what students could achieve in that time), and establishing a tutorial system so that students would have 30 minutes per week in groups from 10 to 12 in size. A reduction in course content would not have been acceptable, so the lecturing strategy involved delivering the material at a more rapid pace than in the past, knowing that students could review all lecture materials outside class time. Students were also required to read a specified course textbook and other printed references held in the library. The contents of the electronically available resources are outlined in Figure 2. Students' freedom to inspect or indeed ignore any or all of this information represented an extra dimension of

student responsibility for their own learning not offered in previous presentations of the module.

The main advantage to the students was that all the electronic materials for lectures, practicals, assignments and background work were continuously available. While their printed notes contained the bulk of the course slides and practical exercises, the visual quality of the on-screen slides exceeded the printed versions, and offered colour and high-quality image reproduction which added greatly to some of the topics covered. In this way students could review all slides presented during lectures in their own time and at their own pace. If new slides were introduced during the course, the students knew that they could review them later, and did not become highly anxious scribblers when they were shown during lectures.

Several videos or video clips were shown during the lectures. In the past, some students have asked to borrow the tapes after class, an option which is less viable with larger group sizes. By electronically providing summaries on PowerPoint slides, students found this review facility adequate, and there were far fewer requests for video loans than in previous years. These video review files were particularly heavily accessed during the end-of-course revision week.

During the year the ScreenCam product by Lotus was used to provide some multimedia course materials. This product records dynamic screen content and optionally a sound track. It proved particularly valuable for recording animated demonstrations of user interfaces of key relevance to the course. Depending on the screen content and movement, a IMB file would record about 5 minutes of animated demonstration. Spoken commentary could be added, but at an additional storage cost of about IMB per minute, and was therefore used sparingly. These

animations were each shown once during lectures, but most students looked at them again in their own time, and enjoyed the control provided by the replay, pause, and fast-forward facilities of the viewer, allowing them to examine details as closely and as often as they wished.

The first consideration in rebalancing use of available class time, to reduce lecturing time without sacrificing quality of exposition or motivational impact, fitted in with the author's evolving lecturing strategy. Over the years teaching slides have been developed and refined, and now exist as some 550 colour PowerPoint slides. This year, as in the last 3 years, black and white miniatures of many of these slides were reproduced as notes for students, so that during lectures they have only been obliged to make marginal notes rather than the detailed records of the past, in which speed of writing and fear of missing important facts were commonplace concerns. The printed notes have proved extremely popular with students. Effectively the course material development costs have been spread over several years, and experience has shown that the printed notes help to reduce the lecturing time for a typical topic by the order of one-third.

Secondly, it was important to maintain and develop the successful approach to practical and assignment work used in recent years. The students were provided with some 35 printed pages of structured practical laboratory work. They were advised to attempt the various exercises soon after the corresponding lecture, but were quite free to proceed at their own pace. Most followed the suggested timetable, but a few chose to progress much more quickly. The full text of all printed practical materials was also available on-line, so that unavailability of a student's handout did not prevent practical work. Access to these files was not often required, but for some

students occasionally enabled productive use of potentially wasted time. On-line provision of relevant code fragments, samples of complete code or full simulations provided a rich set of resources which were extensively used and favourably commented on in informal feedback.

Thirdly, the topics considered in the tutorials were also tightly integrated with the lecture series. These sessions were highly effective in identifying and correcting areas of student misunderstanding, and of making students think through and attempt to apply concepts they had encountered. By this process of dialogue the students came to distinguish more clearly those topics they really understood and could apply from those they thought they knew, but had not adequately mastered.

Technical implementation

From the start of teaching to the end of the examination period, a spare IBM compatible 80386 PC with 120 MB of disk storage was attached via a 10 Mb/s ethernet link to the local area network. Pilot work had used WWW server software to make relevant files available. Technically this worked very well, but it became evident that system maintenance could become burdensome - as a new file became available, a corresponding HTML file had to be edited. For the live trial it was decided to use an ftp server with robust performance and comprehensive control of access privileges. For most of the semester students used a Windows-based ftp client to gain read access to the prepared subdirectories and files, and were given write permission into an 'uploads' subdirectory. Although use of the standard ftp client presented no difficulty to these computing students, an update of the ftp server software two-thirds through the teaching period allowed access by any WWW browser, in practice

Netscape, and it immediately became their preferred access tool. This provided users with a familiar and easy to use interface, and accessing the ftp server now automatically generated a clickable list of subdirectories and files. By attaching PowerPoint and ScreenCam viewer software as helper applications to Netscape, students accessing slides or ScreenCam movies simply had to click on the required file. Once material was placed on the ftp server, it was not modified, except to update announcements and correct typographical errors. This ensured that students had no anxiety that server contents would change unexpectedly, or that required information would be removed.

Pilot work had indicated that it would be of value to record commentary for each lecture slide so that some material might be presented only in a 'lecture-on-demand' format. This plan was dropped largely in the light of experience elsewhere which showed that video-recorded lectures failed to be adequately engaging. Also, although the sound reproduction quality was good, and was very acceptable when listened to in a quiet room, the background noise in a laboratory full of equipment and students became distracting after a few minutes. There is ample evidence that high sound quality is essential, otherwise users will abandon a presentation. It also became evident that the production of even near-professional sounding commentary becomes quite time-consuming, requiring full scripting, and often needing at least a second 'take' of the recording to eliminate minor speech flaws. In the absence of the sufficient time to prepare extensive materials, the use of recorded speech was limited to a small number of files.

The ftp server made it possible to monitor usage patterns, however, access was deliberately made available by anonymous ftp to afford individuals privacy in using

the resources. Inspection of server log files revealed the files that were of most interest, and students could be reminded of the presence of ones that few had accessed. On average, students accessed the server five or six times per week, and in the week prior to examinations access levels were particularly heavy. In discussing usage patterns at the end of the course, it became evident that some were much heavier users than others, but all reported accessing the server at least once per week. The relatively modest PC server supported the demand well. It was theoretically capable of serving 40 users simultaneously (though its response time would have become very slow under such a load), but the observed peak of simultaneous access was only 5. At that level, the response to the users would not normally have been much reduced, because most time in an ftp session is spent on inspecting subdirectory contents. Changing to a different subdirectory normally involves transmission of only a few hundred bytes. In most ftp sessions only a few files were copied. The typical file of slides was around 1MB in size, and this normally took from 10 to 20 seconds to transfer depending on general network traffic load. Students found the response time very satisfactory given that they would normally spend a considerable period looking at the file. It became evident soon after the start of the module that many students wanted to take files home, and they requested that the larger files should also be available in compressed format so that they would fit on to floppy disks. The effort involved in providing a compressed copy for each large file on the server was minimal but much appreciated by the students.

In requiring students to use ftp to upload software they produced for an assignment, the main benefit to the author was ease of access for marking (after checking for

viruses!). Two side-benefits were, first, that the students knew the files would be time-stamped and that late submission would be very visible. Second, with agreement from the students, this coursework remained on the server and available for viewing by all students. When marked, students were informed of the highest scoring assignments, and most accessed at least one or two of these good examples.

Evaluation

In this section the value of the electronic resources is assessed, first in some observations of my own as lecturer, and then from formal and informal student feedback. While some of the observations relate only to the resources, most involve more general observations about the overall course—not surprising since the aim was to make the materials integral to the course. The results presented here are no more than indicative, bearing in mind that comparisons with the previous year involve multiple uncontrolled variables, such as general class ability level, course content, examination papers and **quality of lecturing**.

From the course organization perspective, the ftp facility enabled the module to run more smoothly than in previous years. Throughout the term attendance at lectures remained high, and similarly for tutorials and practicals. The discipline of providing a well-structured set of resources almost certainly helped to sharpen the structure and coherence of the course. The effect of grouping students into small tutorial classes significantly increased cohesion and social integration compared to previous years. Although neither of the following two points seems of much importance, taken together they made a useful contribution to the efficiency of course operation. First, class announcements were prepared in the form of slides and presented at the start of a class.

Despite the almost inevitable late arrival of a few stragglers, there was rarely any need to repeat the information because it was up to these students to view the information afterwards. In practical terms this often turned 2 or 3 otherwise wasted minutes into additional lecturing time. Second, on-line availability of all slides and notes all but eliminated the time required to supply students who 'missed last week's handout'.

In the formally administered university module assessment questionnaire, several students listed the availability of the electronic resources as among the most satisfactory aspects of the course. It was possible to compare these scores with ones taken the previous year. On a scale of 1 to 4 (higher for better), the overall assessment of the course rose by 0.14. Of the 15 more specific criteria, none of the scores had fallen from the previous year, and the three showing most improvement were:

- student participation encouraged by discussion/debate— up 0.64;
- lecturer aware of learning difficulties within the group— up 0.35;
- material delivered in an interesting and understandable way—up 0.12.

The first point clearly reflects the increased dialogue component in the module, and the second may reflect (if inconclusively) improved support for different learning styles.

In an open comments section, as in previous years, the notes and slides were mentioned by 75% as being among the most satisfactory aspects of the course. Less measurable, but no less real, was the sense of enthusiasm sometimes related directly to the course material,

partially due to their (correct) perception that some of the material was freshly collected from national and international sources, and that new components (often located on the WWW) would be referenced.

At a meeting at the end of term, students' views were sought about the ftp facility. All considered it either valuable or very valuable. Several commented that they found it particularly helpful to be able to copy these materials to look at on their own PCs. Although students were encouraged to speak freely, apart from mention of the occasional downtime of the ftp server, no negative comments were offered.

Finally, student performance in assignment work was slightly up from the previous year. Average marks in examinations rose by a surprising 5% from the level which had prevailed over several years. Naturally examination papers vary from year to year, but the intended standard set had not changed. All that can be confidently said from this is that there appeared to be some improvement in the academic levels achieved, and certainly no deterioration.

Electronic Course Delivery

As human beings, knowledge is just one of a number of different commodities that arise and develop as a result of our perceptions of the events and processes that occur both within ourselves and within our environments - the worlds that exist beyond each one of us as individuals. Of course, this statement must not be construed to imply that knowledge is a uniquely human property. Other animals and some machines are said to be able to acquire and process this vital resource. However, this paper is primarily concerned with human knowledge and how this might be shared and distributed using computer-based technology. Some of the other important commodities which relate intimately to the ways in which we acquire and structure knowledge as a result of our perceptual and cognitive processes include signals, data, information, meta-knowledge and wisdom. Each of these items plays an important role in the intricate tasks involved in observing, recording and monitoring events and happenings and of disseminating and communicating to others the knowledge that is derived from these processes. Obviously, the basic activities referred to above form the fundamental foundations of a generic class of systems that are commonly referred to as *'knowledge transfer systems'*.

Within the context of education and training, the basic model that we propose for knowledge transfer. This shows how scholars and researchers within a particular

subject domain create new knowledge and, in so doing, cause an expansion in the universe of discourse relating to that subject.

In order to ensure that this new knowledge gets passed across to new generations we have created various sorts of educational system. Within these systems 'teachers' usually have to assimilate a subset of this knowledge and then 'teach' it to students.

Through the acquisition of this knowledge, students become new scholars and researchers (thereby propagating the cycle), an informed society and a skilful and competitive workforce. Unfortunately, formal education in most countries ceases after the onset of adult life. As a consequence of this, there is a vast industry developing in the area of post-compulsory education—for the support of leisure activities, entertainment purposes or career development and enhancement.

Within the context of both conventional and post-compulsory education we propose that electronic course delivery has much to offer in terms of the efficiency and effectiveness of knowledge transfer. Furthermore, it is our contention that this approach can form a sound basis for the realization of an ongoing learning society that is supported by a flexible and dynamic approach to knowledge dissemination through the creation of a new type of organization which we refer to as the virtual university. We envisage such an organization providing an infrastructure to support both conventional approaches to education and ongoing on-the job learning and training activities within industrial and commercial settings.

Bearing in mind what has been said above, the remainder of this paper outlines the basic requirements of a system to support electronic course delivery through the development of appropriate course materials that are

delivered by various electronic means - such as electronic books, on-line lectures and computer conversations of various sorts. We also outline how the creation of appropriately designed electronic performance support systems can be used to facilitate ongoing learning and training activities within both academic and nonacademic settings. Finally, we discuss how these resources can be integrated in various ways to meet the requirements of a versatile and comprehensive future learning society based upon global knowledge sharing.

In order to facilitate the transfer and sharing of knowledge, human beings have, for centuries, used a variety of communication aids (such as maps, books, journals, papers, art, the spoken word and music). As time has passed these aids have had to evolve and adapt in order to support the ever growing and diverse types of knowledge that are continually being created. Historically, there have been four significant advances in communication technology to facilitate knowledge transfer.

- various aids to facilitate reading and writing activities;
- printing/photocopying for the mass distribution of information;
- radio and TV broadcasting for the global dissemination of non-interactive, non-print material;
- the use of computers for the realization of interactive information systems.

Presently there is a move towards the global sharing of electronic resources through the use of an 'Information SuperHighway'. Obviously, this represents a further important development with respect to the creation of technologies that support knowledge sharing.

System builders and implementors must therefore choose those technologies and techniques that are most appropriate to the situation in hand. In this context, each of the developments listed above will have its particular strengths and weaknesses.

Obviously the communication and information storage technologies that are employed will significantly influence the mechanisms that are used in order to store, retrieve, disseminate and present information to users. Furthermore, the ways in which knowledge is presented to consumers will also depend critically upon the technologies used for its communication and display. In the past, and to a large extent even today, paper-based technologies have been the ones most extensively used for knowledge sharing applications. However, in the light of new developments in information technology it is important to consider whether or not paper is still the most efficient and effective way to record and disseminate information and knowledge. Within educational systems the issues of efficient and effective knowledge transfer are particularly important - especially, in an era of diminishing financial support. For example, in many universities, lecture courses (that are augmented by books, journal articles, handouts and other print-based resources) are very often presented to large groups of students. Frequently, these lectures are relayed electronically (and in a non-interactive way) to various other sites—either simultaneously or in a 'canned' format. Naturally, there are many limitations associated with these traditional teaching methods. Bearing this in mind, we believe that electronic course delivery is a viable alternative delivery mechanism to facilitate the efficient and cost-effective presentation of learning and training resources within a university and/or college context.

Electronic course delivery (ECD) is concerned with the use of electronic materials and delivery platforms to support and enhance teaching and learning experiences—either on an individual or a group basis. In order to realize the goals of ECD there are a number of underlying areas which need to be addressed. These include the use of electronic lectures; mechanisms to facilitate lectures-on-demand; the extensive use of tele-teaching, tele-tutoring and collaborative learning at a distance; and support facilities such as electronic libraries. Obviously, the use of electronic libraries will be an important foundation for the successful use of ECD. It is through such facilities that users will gain access to electronic books, magazines, journals, newspapers, Internet resources and various other artefacts that are published electronically using 'digital paper'.

Of course, as well as ensuring that the necessary storage, communication and delivery technologies are in place to support ECD, it is also imperative that appropriate software and courseware resources are made available. Naturally, the courseware products that are used must fully implement three important pedagogic activities. First, they must provide methods and strategies which will ensure that students are adequately assessed; second, they must embed appropriate remediation facilities (for use in situations where their use is deemed necessary); and third, they must make available suitable performance support tools which will facilitate effective and efficient skill development. Some of the issues involved in making provisions for these requirements are discussed in the following section.

Assessment, remediation and performance support

Information is a fundamental prerequisite of learning activities and problem solving. With the advent of the Information Superhighway individuals are able to browse

or search a vast distributed information resource and retrieve information in a wide range of media forms. What is often lacking, however, is any consideration of how such information is processed by the reader, thus becoming usable knowledge. This section addresses some of the issues surrounding the facilitation of information use. Such facilitation can take place either with respect to the provision of working knowledge (to address current task problems), or to the provision of deep knowledge (providing understanding in the longer term). Information can be enhanced through the introduction of performance tools and/or assessment and/or remediation strategies. In other words, access to information is not sufficient to allow knowledge sharing. It is the changes that occur in end-users which are the key to knowledge sharing. These issues are addressed in this section.

Assessment and remediation

In order to provide understanding in the longer term reflection or reflective observation need to be initiated in users. Reflection implies an interaction with information without which knowledge transfer could not take place. Often, individuals reflect on their learning experiences while not actively engaged with an information resource. This can either be a subconscious process—typified by the Gestalt notion of illumination or the conscious processes that learning materials are intended to foster. In other words, knowledge transfer implies processes that can be encouraged or facilitated and go beyond the simple viewing of information. There are several issues involved in the transfer from information into deep knowledge. First, it is important to develop mechanisms that can actually assist the conversion process. Second, it is important for users to be able to assess their progress. Third, any discrepancies that arise between information content and users' interpretations must be remediated.

One of the most important techniques that can be used in this regard (and one that is used in many learning situations) is the use of assessment strategies. When people are engaged in learning they need to interact with the material. Unfortunately, for many people, information access can often be a relatively passive process unless targeted at undertaking specific tasks. Nevertheless, people often do access information to gain knowledge rather than to solve particular problems and it is under these circumstances that the provision of mechanisms for the application of information becomes **crucial**.

Assessment has a number of useful characteristics that can be utilized. These can be summarized by the following points: motivation; activity; completeness and correctness. For many people, assessment is inherently motivating. People actually want to know how much they know. It also links into basic competitive drives which cause individuals to strive for high performance. Of course, engaging learners in a practical activity allows them to apply what they have learnt. It takes students away from relatively passive information processing to an active style of interaction. Furthermore, the corollary of individuals having an indication of what they know is that they can also become aware of what they do not know. This includes information that has been misinterpreted and/or misunderstood. Finally, assessment provides the mechanism by which the need for remedial action can be identified. This can be action initiated by the student as a result of computer-based feedback. On the other hand, it can originate from a learning facilitator who may be monitoring student progress electronically as might be seen in a computer-based distant learning programme.

As was suggested, assessment is a useful mechanism for monitoring progress and giving learners an indication

of how well they are doing. If necessary, remediation can then be used to help those who are under-performing. In contrast, performance support techniques are intended to extend human ability beyond the levels that are normally accessible to them. The study of performance support is therefore concerned with the design and provision of mechanisms, techniques, technology and tools to facilitate and augment an individual skill and knowledge performance within a given task domain. The tasks that are involved may be either physical or intellectual.

Increasingly, computer technology is being used as a basis for the realization of performance support systems. A system that is based upon some form of embedded computer facility is often referred to as an electronic performance support system (EPSS). According to Banerji an EPSS can be defined as 'a human-activity system that is able to manipulate large amounts of task related information in order to provide both a problem solving capability as well as learning opportunities to augment human performance in a job task by providing information and concepts in either a linear or a nonlinear way, as and when they are required by a user.' There are two important implications of this definition. First, the use of a just-in-time (or on demand) instructional paradigm; and second, the use of an on-the-job learning/training situation.

Electronic performance support systems are now increasingly being used within educational settings. When used within this area an EPSS can help support staff and students in two important ways. First, by accelerating skill and knowledge acquisition. Second, by enhancing the ability levels of both staff and students. In order to accelerate skill acquisition, computer-based assessment tools can be used to provide assessment mechanisms that provide real-time monitoring and feedback. In addition, advanced knowledge-based tools

(such as expert systems and intelligent tutoring facilities) can be used to deliver deep knowledge and remediation embedded within the context of original learning/training tasks. Through the use of EPSS techniques, students and staff can thus be provided with more complete, varied, valid and stimulating knowledge.

Numerous examples of the use of EPSS techniques within education are now starting to appear in the literature. Stevens and Stevens, for example, describe the 'School Year 2000' initiative in Florida, USA. This is intended to provide students, teachers, administrators and others involved in the education of children with performance support tools in eleven different areas - including curriculum planning, instructional management, assessment, delivery of instruction, access to educational resource materials, and so on. Similarly, within a university context, Barker *et al.*, have described the application of EPSS techniques for the operation of an electronic, open access student information service' (OASIS). The electronic OASIS is a basic mechanism to support ECD based upon the use of electronic lectures and various forms of automated (computer-based) assessment of students.

The three case studies described in this section illustrate some of the ways in which ECD is currently being realized within our own organization. They deal with the use of electronic lectures, distributed performance support and the embedding of pedagogic structures within electronic course material.

Electronic course delivery necessitates thinking about new ways of making teaching and learning resources available in electronic form. One of our first experiments in this area was to look at the feasibility of using electronic lectures as a mechanism for: improving the quality of 'stand and deliver' lecture presentations;

and making available 'augmented' lecture material as a self-study resource for open and distance learning activities. In order to study potential improvements in the quality and effectiveness of conventional lecturing techniques, we persuaded a number of staff members within our organization to adopt the use of computer-based presentation packages. Staff used these packages for: creating their teaching material; and subsequently delivering this material 'live' to student groups in conventional lecture theatre environments that had been equipped with appropriate projection equipment. Student attitudes to the use of these electronic lectures and their comments on the quality of the materials were assessed using questionnaires', the results are documented in detail in Tan. Two different approaches to the development of electronic resources were explored. First, the conversion of existing material into a more dynamic electronic format; second, the creation of new lecture material directly in electronic form. Each of the authoring processes was studied in some detail in order to identify problem areas and specify appropriate tools that could be used to overcome the difficulties that staff encountered in using electronic authoring packages.

Once a stock of electronic lectures had been created and stored in a central database facility, the second phase of the study was initiated. This involved making electronic lecture material available to students in various ways for self-study purposes. Three different approaches were considered:

- distribution on conventional floppy disk;
- publication on CD-ROM;
- providing access to lectures via the department's intranet facility.

In each case, book and library metaphors were used to

facilitate end-user access to the resources. Undoubtedly, one of the most useful approaches to self-study access was the intranet facility since this allowed the incorporation of student self-assessment material (in the form of on-line tests) that could be automatically marked by the computer -with feedback being given directly to students and sent back to teaching staff. Of course, just taking electronic lecture material and making this available to students is not a sound pedagogic strategy since some extra accompaniment is needed in order to compensate for the absence of the lecturer's narrative. We are therefore currently investigating audio, graphical and textual techniques for augmenting lecture material in various ways. These techniques will be supported by appropriately designed automation tools to facilitate the necessary augmentation techniques.

Distributed performance support

Implicit in the work described in the previous case study was the underlying use of electronic performance support techniques for the creation of highly supportive teaching and learning environments. As well as the creation of electronic lectures, another important facet of the work was the creation of an electronic, open access student information service from an existing manual system. The Electronic OASIS was designed in such a way that it formed a highly distributed electronic performance support system (DPSS).

The Electronic OASIS system that we developed was based upon the same type of client/server technology as is used within the World Wide Web (WWW). Indeed, the only difference between our system and a conventional WWW server is the fact that our resources are not publicly available to people who are not members of the university. It therefore uses the same approach to resource provision as is used in the WWW. That is, materials are 'marked up' using HTML (HyperText

Markup Language) and Java and are then mounted on an intranet server. Users can then access these resources (via the campus-wide network) using a standard Netscape browser. Common gateway interface (CGI) programming techniques are used in conjunction with the browser to facilitate on-demand on-line testing of students and the administering of interactive questionnaires relating to the quality control of courses.

As well as making available electronic lecture material for self-study purposes, the intranet facility also provides access to an electronic library of study resources to support the various courses that we run. Access to previous exam papers (with solution guidelines), case study material and practical class exercises is also possible. Students (and staff) can obtain copies of any of these materials (electronically) using any of the computer workstations that are attached to the local area network facility that forms the backbone of the distributed performance support system.

In order to extend this work to other departments and divisions within our university, a number of other electronic OASIS systems are being created in several of the other administrative units of our organization. The long-term intention of this DPSS project is to provide a seamless electronic course creation and delivery environment that is available to all students and staff of the university - no matter where they happen to be located. Fundamental to the realization of this goal is the provision of suitable interactive environments to facilitate the design, development and sharing of electronic course materials that embed a wide range of different pedagogic strategies. Some of the issues involved in doing this are discussed in the following section.

Since knowledge sharing implies far more than simple information access, it is important that the

mechanisms which allow information to be incorporated into a person's cognitive functioning are considered. In order to investigate this more closely, Race's model of learning was applied to the development of educational software designed to transfer knowledge about statistics to adult learners. At this stage, guidelines had already been developed based upon Race's model, however, they were still in an untested form. The objective, therefore, was to design a learning package which would take into account all four aspects of Race's model: Wanting; Doing; Feedback; and Digesting. In the process of designing, implementing and evaluating the learning package a number of clarifications and developments were made to the guidelines. These developments resulted directly from the experience of using the model in a practical setting and analysing the responses of participants.

The guidelines were employed in the design of a computer-based learning package (called 'Statistics for Psychologists') aimed at teaching statistics to newly starting undergraduate psychologists. Since the package was directed at students who were about to undertake a traditionally taught course, open-learning was felt to provide the most appropriate mechanism.

Open-learning systems provide flexible access for students to training materials. This gives students some choice over when they study, the length of each study session, and also the pace at which they progress through the learning materials.

Although open-learning systems do tend to provide such benefits, there can often be drawbacks associated with such an approach. First, the large degree of flexibility provided means that it can be impractical to provide on-hand subject-expert support to assist information transfer. In addition, system users may not

know the limitations affecting knowledge transfer and may therefore be unable to take remedial action. As a result, it is essential that mechanisms such as knowledge testing are embedded in information sharing applications as cognitive transfer tools for users.

Table 1 Some basic guidelines for use in educational software

1. Wanting must be consciously programmed into courseware.
2. Two ways of embedding wanting: increased value and increased enjoyment.
3. Avoid passive interaction.
4. Support practice and/or trial and error learning.
5. Provide students with a sense of progression.
6. Encourage use within a social context.
7. Embed computer-based student evaluation.
8. Encourage reflection away from the computer environment.

The 'Statistics for Psychologists' learning application is designed to take account of pedagogic strategies and guidelines to facilitate knowledge transfer. The two key mechanisms employed in this regard are highly interactive protocols and computer-based assessment. These mechanisms can improve motivation, assist in the organization and assimilation of information, and help remediate inadequacies in knowledge transfer. In this application, users select answers from either the answer button bar or the table of data which forms the basis of the questions. This encourages users to organize their thoughts, identify limits in their understanding, while at the same time providing a highly interactive environment.

Inservice Education

The main focus of this chapter is on the in-service education of teachers and teachers' centres as established over recent years. This chapter, however, argues for a complementary development of professional centres based upon institutions of higher education as an important alternative and extension of the concept of teachers' centres. The thrust for the current national review of in-service education was provided by the report of the James Committee in 1972(1) in which it was argued that "the best education and training of teachers is that which is built upon and illuminated by a growing maturity and experience. Teachers' centres organized outside the colleges of education can, of course, make a major contribution to this provision. It is, however, vital that those agencies providing initial training of teachers should also play a central part in in-service education.

The proposals regarding initial training assume an established pattern of continuing education and training of teachers, and take the twin objectives of initial training as being to equip the student to be as effective a teacher as possible in the first assignment, and to provide him with a basis upon which his in-service training can be methodically built. Equally they assume that the student has, in the formal sense, "completed" his initial education and is now sharply motivated towards teaching.

Following the publication of the report, in-service

training has become detached in public argument from the question of initial training and the development of professionalism in teachers. However, if such a view predominates and in-service training is separated firmly from initial training, it will fail to realize its full potential. The main argument for seeing that colleges of education and other training bodies have a continuing role in induction and in-service work is based upon their continuing responsibilities for initial training of the nation's teachers. It would be unsatisfactory for such institutions to carry out initial training unless in their professional work they are entrusted with some responsibility for the continuing education of teachers.

It is extremely difficult to generalize about 150 institutions varying widely in size, location and character. Colleges will shortly be designated as further education institutions, and various forms of diversification will follow.

A small number will merge with polytechnics, and one at least with a university. Others will merge with colleges of technology, and some remain independent but with additional courses in fields other than teacher training. The reference groups for the colleges will be more diverse, and they will be less dependent upon links with a university. In in-service training the regional authority will be a consortium of interests, in which the university and college will be only a part, with teachers and local education authorities playing a substantial role. For the purpose of this chapter, however, it is assumed that the institutions of which we are thinking have a significant higher education role, with a central core of teacher education and substantial in-service responsibilities. This would be true whether the colleges are acting independently or within the context of a much more generalized further education provision- normally of an advanced kind.

The professional centre

It is hoped that all higher education institutions with a major concern with in-service training will establish a professional centre. In a limited number of cases it is possible that a small college may, in fact, become a professional centre concerned solely with in-service education and training. In most institutions, however, work with qualified teachers will be a part only of the purpose of the college. Indeed, any institution concerned solely with in-service training will be able to provide only a part of what a teacher essentially needs as a fully professional person for whom continuing opportunity for personal education is also of significance. However, in-service education with the scope now proposed cannot be sustained by the part-time -and frankly peripheral - attention which many colleges give to it. It is essential to concentrate staff, resources and organization to serve the special and continuing needs of practising teachers. One way of ensuring this concentration is through the establishment of a professional centre which is the responsibility of a senior member of staff, with its own board representative of the various interests in the field of in-service education. If a college has a series of schools or faculties, then such a professional centre should have equivalent powers, a substantial budget and a well-articulated policy which has been agreed by the college's academic board, governors and local education authority. It should have power to respond to requests, as well as to initiate major programmes; it should be given responsibility also for research and inquiry in what is the most critical field of development in the whole of teacher education. Such a structure would enable the colleges to make a substantial contribution to induction, in-service and innovation.

The induction period is the essential bridge between training and teaching, and much of the quality of the

profession and the response to future in-service opportunities are dependent upon what is done in the first year of teaching. It is also a key stage in the professionalization of the teacher. As the White Paper points out, "induction should offer a systematic programme for professional initiation, guided experience and further study. To do so, teachers must be released for not less than one-fifth of their time for in-service training." The whole direction of courses and guided experience should be to support and help the new teacher to become more skilled and adequate as he works his way through the various stages of his concentrated and decisive professional experience. Central to the entire development will be the role of the professional tutor. The colleges have an important role to play, although from the beginning it must be clear that this should in no way be prescriptive. It is neither possible nor desirable to sit down and plan a 1 day a week course for the 200 inductees who may take up appointments within easy travelling distance of a college. It is necessary to be familiar with the schools in which the new teacher will be working and to have close liaison with the professional tutors, the advisers and headteachers. The programmes of support and guidance should be closely related to the individual needs of the different teachers, with group seminars, access to resources, and introductory sessions common to all working within particular kinds of school. Much else will be individual and group work, done sometimes in the college, sometimes in a teachers' centre, and often in school.

One approach would be to have an "assigned tutor" who would establish and maintain a working relationship with a group of schools. The tutor would assist with in-service programmes for such schools, make a contribution to teaching in the school and hope to gain the confidence and respect of the head and his staff. In

co-operation with the professional tutor he should meet the new teacher at very beginning of his year and, if possible, before he has actually taken up his appointment. The need for more students to be appointed to specific schools and to know about them well before they take up their jobs in September is urgent if one really wants teachers to feel some commitment to the schools and children with whom they are working and to feel that are being treated as properly professional people. Any new teacher faces problems and one task of the assigned tutor is to try link the teacher's induction period study both to his classroom difficulties and to whatever kind of initial he received. While the "assigned tutor" should be seen to be closely identified and actively co-operating with the professional tutor, he should also provide opportunity for contact outside the context of the school, and provide a listening ear for the young teacher without being identified with the status system either within the school or within the authority. The college could provide a social base for the young teacher, as well as full and free access to the library and to audio-visual and other resources. The new teachers should be given the opportunity also to help trainees by talking to them about the ways in which they are tackling the problems which arise in the first year. This is one extremely important way in which a college role in induction has particular value for initial training.

The "assigned tutors" from the college should be active professionals working also in a school of professional studies concerned with initial training. They will be mainly field-based tutor working more outside the college and in the schools than inside the college itself they will be closely identified with professional tutors, teachers' centre wardens and practising teachers. Indeed, they should form part of a wider professionals group which plays a role in both initial and in-service

training. This, of course, will only be possible if the college regards initial training and induction as part of one continuous process. The core of such an approach is the day-to-day professional experience for the practising teacher. This accepts the need for early concerns, the need to understand the way in which particular children learn, why teachers have certain attitudes, what resources are most appropriate for children of different ages and abilities, the effects of home background, the attitudes of parents, an understanding of the questions which children ask, and the ways in which answers can be articulated or discoveries made. New teachers will need help in recognizing the qualities which are most valuable in particular situations: the usefulness of particular kinds of knowledge and understanding gained from higher education, the value of critical analysis, using such techniques as simulation and micro-teaching, and the consideration of the values implicit in certain forms of the curriculum, and ways of assessing the success of teachers and of children. Young teachers more than their elders are very alive to such issues, but impatient of an approach which is too highly theoretical -at least at the beginning.

A seminar and tutorial approach must be the one adopted for the induction year. This will involve the young teacher in a sharing of experiences and a slow realization of ways in which it is possible to be critical but constructive about one's own performance. It will also help in resolving some of the problems of individual children and of groups by suggesting strategies for using resources, for pacing one's output, and for keeping one's sincerity as well as one's sanity. It would also be the responsibility of the "assigned tutor" and the professional tutor together to help the young teacher to see the way in which he is developing and changing, so that he is able to assess for himself ways in which he is failing and

succeeding so that each year he makes progress or seeks out those who can help him to find areas of work which enable him to greater success. This is the essential challenge of the induction year.

In-service

The professional centre at the college should cater first of all for the individual needs of the teachers in the region as a resource centre, and secondly as a centre for various kinds of courses. The major thing to emphasize, however, is the role of the centre as a resource. The centre will need to be a place with good facilities, an educational technology area, spaces to make things, to experiment with materials and see examples of work done by children and of publications and apparatus for use in schools. There should be a major social area, common-rooms, a cafeteria and accessible parking areas. In addition, all parts of the college should be open: library, where available, laboratories, access to computers, further social facilities such as sports and bar, etc. For the use of the more obviously social facilities some fee may well be charged. It will certainly be necessary to finance from the authority the kind of materials bank which would be involved, and the additional pressure which will be put upon the library and other resources. Initially the major use will be made by teachers, but it is essential from the beginning that the needs of social workers, youth and community workers, and others working in the area should be recognized: indeed, it is important that in-service education should not be organized separately from other services to the community. Teachers will lose out if their continuing education is seen as separate from the improvements of public provision in higher education generally. Also the opportunities for various professions to get together both socially and professionally should be seized. This may begin with a common concern for children, and then extend to the

linked problems which affect families in the area, as well as the various services which are provided. It would however, be preferable if colleges offering interprofessional opportunities were also to train such workers at the initial stage, as the same advantages which would accrue for teacher trainers being involved with in-service would also affect the initial training of social workers and others. Above all, it is now important to work out a realistic budget for such activities, to relate the various agencies together, and to determine the priorities in terms of development.

The modern approach to course design advocated by the White paper is for the use of units or modules which enable courses of various lengths and patterns to relate to each other and to lead eventually to substantial awards. Thus, although there will always be a need for specific and concentrated courses in limited areas, it is no longer necessary to assume that are the only kinds of courses that will deal with the urgent and relevant concerns of teachers, whereas the longer, high-level courses are assumed somehow to escape the need to be relevant and appropriate. The overwhelming desire indicated by Brian Cane and H.E.R. Townsend is clearly for in-service Bachelor of Education degree courses available both part-time and full-time. A critical problem is, however, to ensure that the new B.Eds. are much more professionally relevant and flexible than those which exist at the moment. The flexibility should be established not only to fit in with the needs of teachers in professional terms, but also in relation to the opportunities they have for leave and for part-time study. Thus, teachers should be able to obtain qualifications by a wide variety of means: by one-year, full-time study, one-term, full-time interlocking with part-time study, as well as entirely by part-time study. The use of vacations and weekends should be exploited, as should one-day

and half-day release. Tutorial supervision in schools related to curriculum development, and emphasis upon independent study should all free the teachers to tackle urgent professional questions at a good intellectual level. The fact that teachers will be members of the boards responsible for planning courses of in-service training should lend in-service programmes greater relevance to the teaching situation.

A professional centre would enable teachers to have access to higher education courses and to read for a Bachelor of Arts degree as well as for a B.E.d. However, in the main the degree normally offered would be the B.E.d. whilst the approach to main subjects, for example, English, might pay particular attention to the needs of teachers working in educational priority area schools, or to the problem of language and communication at a very Practical and specific level.

On the other hand, a study of areas of literature might lead the students to question the approach of Dr. Halsey and his team in their volume on educational priority, that is that the curriculum in educational priority area schools should be aimed primarily at the critical and constructive *adaptation* of children to the actual environment in which they live and that the balance of the curricular diet should change from "academic" to "social" with reality-based themes forming the staple intake. Again, an English department might pay particular attention to reinforcing the teaching of English to the immigrant child.

There are many practical questions to be answered, although experienced teachers will undoubtedly see, as June Derrick did, that the teaching of English is only one part of the cultural growth of an immigrant in a new environment. Thus, short and highly specific courses on a subject basis will inevitably lead to more substantial and

deep considerations of role of the teacher and the purpose of the school.

One of the major considerations which led the James Committee to put in-service training at the top their priority list was the impossibility of preparing a teacher at the beginning of his career for all the responsibilities he is going to face in a world of rapidly developing social and cultural change.

The current inability of so many schools and teachers to cope with the rapidity of change in curriculum, methods of teaching, and changing motivations and attitudes of children is a powerful argument for a national system of continuing education for teachers.

Attempts to maintain a sabre-toothed curriculum or to return to a traditional relationship with children are both doomed to failure when one comes to analyse the present pace of change in school organization, in social demands, in learning content and teaching methods. However, it must be said that a large number of brilliantly innovative programmes developed by the Schools Council and independent foundations have failed to make any effective impact on the children for whom they were intended. It is, therefore, essential that professional centres should aid the vital task of establishing curriculum change in schools, and thus crucially affect the standard of education which children receive. This thesis has been well argued by Hoyle, who has written persuasively on the strategies of curriculum change.

By curriculum change is meant changing methods, materials, hardware, school organization and educational principles, i.e. virtually any sort of innovation at the school level. It also accepts that the fundamental aim is to improve schools and the educational experiences of

children. In-service training of teachers is one way of achieving this objective. The current patterns of curriculum change rely upon diffusion, research and development and finally problem-solving.

Unfortunately diffusion, which is relatively unstructured, is extremely patchy and uncertain in operation. The search and development approach has had very limited success mainly because of the distorting effects of adaptation, which often means completely transforming the innovation in order to bring it into line with prevailing beliefs and procedures—thereby robbing it of its innovative character.

There is also undoubtedly a lack of congruence between the rational, systematic and intellectualized research and development strategy, and the idiosyncratic, intuitive and individualistic approach of many teachers. Finally, the problem-solving model is concerned with the perspective of school itself, as indicated by the interesting series of lectures by the Dean of the Teachers' College of Columbia where the school is itself a learning system concerned with trying to establish innovation within its own environment. The difficulty here is that such innovation may often be ad hoc and chancy, and it tends to make unwarranted assumptions about the level of expertise and permanency of the staff in a school. This then underlines the need for a professional centre strategy of the kind advocated by Hoyle. The basic premise here is that there is a need for an institution intermediate between the school and the agencies of curriculum change.

A professional centre strategy would reinforce existing agencies. For this purpose the base is assumed to be a college of education. Its functions might be linkage, support, consultancy and in-service training. Thus, the linkage function would be to act as an intermediary

institution between national agencies of curriculum development and innovating schools. Currently the Humanities Curriculum Development Centres established at the Berkshire College and Bishop Lonsdale College, Derby, show how colleges can act on behalf of major project teams, and at the same time give close support to schools within an area.

Thus, the centre would collect, exhibit and make available resources of various kinds, act as a centre of information for what is happening in the locality, link colleges, schools and other institutions, and create awareness of current innovation in schools. Its work would supplement that of local authority advisers and Her Majesty's inspectors. A second function would be to provide continuous support for projects in participating schools after the withdrawal of the development team, and for non-participating schools which would like help and guidance in the adoption and institutionalization of an innovation. A third function would be to provide a base for a permanent group of consultants and act as an agency for people from the appropriate departments of colleges, polytechnics, universities and other institutions who might be able to make a contribution towards assisting change.

Here the two main targets of change are the curriculum and the social system of the school. The consultant would work together with the school staff or part of it as a group, provide theory, analysis, research and support. His interests would include perspectives of the school, the relationships between teachers and pupils, and the organization of the school. A great deal would depend upon the degree of involvement of the schools themselves in the management and development of the centre, so that consultants could be fully accepted.

Professional centre strategy could particularly help

in working with groups of teachers. Much of current in-service training is aimed at individuals rather than the functioning group.

The problem of individuals returning with personal enthusiasm is that it is often hard to sell the innovation to their less-committed colleagues who have not attended the course. However, for a school contemplating a major innovation—such as introducing mixed ability groups—the professional centre could help to prepare staff in a number of ways: firstly, by providing a setting, a support programme and the attachment of staff on a part-time with a specific expertise. Thus, the professional centre could provide much of the support for innovative activity, and give a base for in-service training linked to school programmes of innovation involving functioning groups of teachers rather than individuals.

Research is obviously an important element in innovation. In the National Foundation for Educational Research survey 75 per cent or more of the teachers said that they would like to join working groups of teachers with the definite objective of exploring subjects or topics in terms of classroom teaching which involved participants in practical trials and experimentation with methods, materials and ideas. A cogent argument for such an action programme as opposed merely to developing "taught courses" is the paucity of research findings which can be used to provide an adequate base for professional decisions—this in spite of fact that expenditure on educational research and development has gone from some 200,000 in 1961 to well over 3,000,000 in 1973.

Major professional centres should strongly supported as bases for relevant research. It is to be hoped that the Advisory Council on the Training and Supply of Teachers, and the new Regional Committees will

encourage research in professional centres conducted both by teachers and by full-time researchers. The atmosphere of a centres developing the kinds of programmes indicated above may be a more appropriate base for genuinely useful educational research than units which are loosely attached to certain existing of higher education.

One of the most significant educational developments in recent years in developing countries has been a growing concern about the efficiency of education systems, a concern stemming on the one hand from the enormous financial implications of recent educational expansion and on the other from a mounting disillusion with existing education as a means of bringing about planned change in rapidly evolving societies. Since up to 90 per cent of recurrent educational expenditure may be devoted to teachers' salaries and since the quality of the teaching force crucially affects the quality of educational provision, one might have expected to find in teacher education institutions a ferment of new thinking and concrete research concerning our processes of self-evaluation. Recent writings and discussions on teacher education have indeed reflected the general concern about quality. A great deal is being said about new directions in teacher education, about reform of the curriculum, about the organization of teaching practice and the use of the probationary year.

The potential value of new media has repeatedly been stressed and more recently we have heard a good deal about group dynamics, micro-teaching, and problem-solving techniques. We have also been concerned with raising the quality of our student bodies through improving selection procedures and of our staff through programmes of training. All of this is healthy enough save in one crucial respect. Deficiencies are being defined and reforms suggested but in general without

serious attempts to build into our system any rigorous and continuing procedure, by means of which we can determine the real extent of our deficiencies and the real value of the changes being suggested and in part implemented.

Despite the discussions which have gone on, and in many respects they have gone on in hardly dissimilar terms for many years now, I doubt whether many of our programmes of teacher education are in essence significantly different from those of 10 or even 20 years ago. Even the criticisms and proposals for change have often a tediously familiar ring about them, so that, paradoxically, they are less likely now than then to evoke a vigorous response. One major reason for this situation is that we have been floundering in a morass of self-doubt, neither entirely convinced of the need for change nor of the continuing validity of traditional procedures.

To a considerable extent we have been shielded from criticism of our work by the fact that the general discontent with the role which education is currently playing has inevitably focused on the schools themselves, for which we have no direct responsibility. When the quality of the teaching force is questioned, we respond defensively. We point to the undoubted fact that the massive expansion of schooling in recent years has been bound to affect the quality of the education provided and has inhibited those reforms which we ourselves have long believed to be desirable. In particular we point to the tyranny of examination systems and to the prevalence of social attitudes which favour possession of knowledge or at least of certificates instead of an education more generously defined. We many argue that the teachers we have trained are already embarked on the long and arduous task of introducing change in schools but that they are working to new standards and goals which our critics do not always recognize. We can justly claim that

it is too early as yet to assess the impact of a new generation of teachers on the schools. And meanwhile we plead that more funds be allocated to teacher education to permit more generous staffing and improved facilities and resources. We assume, do we not, that, given more money, we could achieve better quality, our teachers would be better prepared, and the schools better serviced. Yet is this not an assumption which remains unproven? Great strides have been taken in recent years in providing facilities for training teachers. Many of our teacher colleges are lavishly equipped and some at least are attracting staff with high academic qualifications. But are these colleges really so much better than their predecessors and their less fortunate contemporaries?

The answer surely is that we cannot be sure and for the very good reason that the yardsticks which we conventionally use are inadequate and almost universally admitted to be so. These yardsticks are of two kinds. Firstly, we attempt by means of a final examination to establish a standard of academic knowledge and professional knowledge and skill to be attained by all those to be declared qualified to teach. Conventionally such examinations are concerned with the minimum standard and can tell us little about the extent to which we have enabled an individual student to develop to the maximum of his potentiality. Furthermore, what the majority of such examinations do not normally measure (for example personal qualities, motivation, and attitudes), are at least as important in teaching as what they do measure. And since the pass standard normally relates to a single student cohort, it provides a very unsound basis for judgments about the comparative quality of successive or parallel cohorts. Thus even the maintenance of a 100 per cent pass rate over a period of years can tell us only a little about the quality of the training provided by an individual college during the

period. The point need not be laboured. As educationists we, better than anyone else, know the deficiencies of examination systems in general and our own in particular.

It is perhaps because we have found it difficult to assess our products that we often refer to a second set of yardsticks, the inputs into our system, to assert our quality. We tend to rate ourselves according to the number of graduates on our staff, the level of education from which we select our students, and the extent of the facilities we have available. However, those economists who have begun to interest themselves in education, and rightly so in view of the amount of investment tied up in it, are little impressed. They point out that the most important reason for the massive increase in industrial productivity over the last half century is not the expansion of the plant or of the manpower employed but the dramatic improvement in the efficient use of inputs. Education, they have suggested, has followed other major industries in terms of expansion but has failed to make comparable advances in terms of productivity. Educationists have of course retorted that educational productivity is a far less easily definable thing than industrial productivity. The latter may be calculated fairly easily since inputs and outputs are quantifiable and their relation may be expressed in terms of cost. To calculate educational productivity on the basis of costs per student successfully completing a course of study for example would leave unanswered a whole range of crucial questions about the quality of the education received by each student. However, I question whether we are in any sort of position to assert that we are capitalizing to the maximum on the costly inputs which we seek, a very serious matter in view of the high proportion of scarce resource which our countries are placing in our hands.

While we must continue to resist the application to our work of irrelevant criteria and refuse to allow education evaluation to be dominated by purely quantifiable considerations, I would contend that education must be equally as cost-conscious as industry and that our concern for quality must be tempered by concern for efficiency in cost terms. While much of our work cannot be subjected to cost-benefit analysts, there are certain aspects of it which not only can but should be so analysed.

A highly rewarding study might be made of staffing, to which such a high proportion of recurrent expenditure is devoted. There is little to be learned from across-the-board studies such as the cost per lecturer/hour but a good deal might be gained if it were preceded by a careful analysis of the tasks to be performed and being performed within the college. These tasks may be categorized roughly as teaching, research, and administration and it should be possible to calculate on a time basis the amount of effort devoted to each by individual staff members and thereafter to cost this effort. Comparison between institutions might well throw up interesting discrepancies worthy of further inquiry but I would conjecture that such a study, even when limited to a single institution, would reveal the wasteful use of staff members in performing tasks for which their experience and training have not fitted them, which detract from their ability to perform their other duties, and which might more cheaply and efficiently be undertaken by more junior or specialist members of staff.

Similar studies could be made of the use of plant and equipment which cost again providing the yardstick. However, such studies will not tell us much about optimum costs or procedures since what is cheaper is not necessarily better. Thus we are again throw back on the

basic question of whether we can establish more satisfactory measures of quality.

There are many reasons why we have not so far done so including the impact of educational expansion upon the limited pool of staff component to perform some of the operations I am suggesting, and such factors as this will continue to make them impractical in a number of Cinderella institutions. But where the opportunity does exist, for example in the newer secondary school-oriented colleges, the most important reason for our failure to device such measures is that we have not defined for ourselves in any comprehensive yet practical way the goals at which we are aiming. Only when we have defined our goals can we agree upon what constitutes quality in our work and only then can we establish to what extent that quality may be measured. The fact that in certain important respects we are likely to find it impossible to apply precise yardsticks does not free us of our responsibility to go as far in this direction as we can. Beyond this point we may still need to rely on subjective impressions but these will be the more valid to the extent that they are informed and the more informed to the extent that we know what we are looking for. In a short article such as this it will hardly be possible to do more than to expand upon this point and to discuss some of its implications in a general way.

We must recognize at the outset that a distinction may be drawn between what have been termed 'internal' aspects of quality, that is to say the extent to which an institution achieves the purposes it sets out to achieve, and 'external' aspects of quality, the extent to which the institution meets the real needs of the society it serves. Ideally of course the two would be in harmony but this is by no means a universal characteristic of our current systems. A number of criteria govern the formulation of the goals we have to define for ourselves. It is important

that these goals should be generally acceptable to all who will be required to work towards them, that they should as far as possible be defined in terms which lend themselves to evaluation, and that where precise measurement is inappropriate, they should constitute a common frame of reference, against which we may seek to judge ourselves and others and submit ourselves to the judgement of others. It is also important that the goals we prescribe cover the whole range of our activities and establish priorities both between and within different activities.

The most important function of any teacher college is of course to train teachers and clearly our aim must be to produce good teachers or at least teachers as good as we can possibly make them. Immediately we are in danger of plunging into a prolonged and involved debate as to what constitutes a good teacher, a process which is often inordinately satisfying to the argumentative and unbearably frustrating to the practical man who seeks simple guidance. If we are not careful we shall find our definition too lengthy, complex, abstract, and diffuse to be workable for our purpose here. Without denying the value of such debate and without underestimating the difficulty of securing a definition which is both acceptable and satisfying to all our colleagues, I would assert that it must be possible to agree upon what we expect of a student at each stage of his training and to express these expectations in concrete behavioural terms, to limit our definition to the bare essentials and if necessary to those bare essentials upon which we can all agree.

Equipped with such a frame of reference we should be in a far stronger position to develop examination techniques able to claim far greater validity than our present arrangements. From the range of techniques

available we should be able to select the one most appropriate for the testing of a particular aspect of student performance, knowing not merely precisely what it is we are looking for but also how this particular assessment will fit into the mosaic of variegated assessments which will provide the basis for an overall assessment. In so far as the frame of reference is unique to an institution, the problem of relating its quality to that of other institutions will remain with us. On the other hand it seems to me likely that the extent of common ground will be sufficient to make cross-institutional comparisons possible. At this point, however, I would stress that it seems to me to be crucial that the goal of an institution be defined in their final, precise, and measurable form by the staff who are to work to them and that for a detailed frame of reference to be prescribed by higher authority, for instance, would largely undermine its value. Similarly it is unlikely that a centrally administered examination will meet the need, though in current circumstances one would admit the right of administering authorities to prescribe certain common examinations and indeed to retain a wide measure of control over assessment in respect of institutions which are not yet capable of operating autonomously. Autonomy may well in the final resort be essential to efficiency and the need for common standards between institutions may well be best met in the manner accepted between other autonomous institutions of higher education, namely through cross-moderation of syllabuses and examinations, preferably through the use of teams of moderators rather than the traditional single moderator or group of independent moderators.

A distinction must be drawn between the quality of the product and the quality of the process and the quality of the process of teacher education. I would not

regard an institution as necessarily efficient if it graduated a small number of teachers of the highest calibre but at the expense, for example, of a high wastage rate and by employing scarce and expensive resources at a rate incommensurate with the quality of the produce. Indeed direct measures of attainment of students on graduation may conceal considerably inefficiency in the process of their training and may really reflect far more their attainment at the beginning of the process or the strength of socio-economic factors depressing or boosting student performance. We should certainly need to develop a pattern of continuous assessment capable of being used to inform us about the extent to which students are being taken beyond their individual base-lines and to assist us in diagnosing weakness in our work. But we should also require a variety of indirect indicators of efficiency, among which drop-out and retardation rates, attendance rates at various kinds of activity, staff retention rates, teacher/student contact hours, library utilization rates, staff-student ratios, and mental and physical illness statistics might figure. There are measurable indicators, which can be used for purposes of comparison between institutions and over periods of time in a single institution.

These possible indicators of efficiency in the process of training are predictive in character. By examining their relationship to attainment indicators over a period of time we may be able to establish which factors significantly affect attainment and to what degree. However, we will still be dealing with probabilities rather than proven facts, since the value of predictive indicators must depend upon the extent to which we can make attainment evaluation consistent and reliable. Up to this time little work has been done to test these indicators and to compare their usefulness, although one notes that of late doubts have been cast on the value of certain traditionally respected indicators.

In any case the proof of the pudding is in the eating. Possibly the best way of evaluating the training which a teacher has received is to study his performance in the field and to hear his views when experience enables him to sift the wheat from the chaff of his training. Again it would be futile to suppose that we can establish a direct measurable relationship between training and performance, or rely too heavily on the opinions of former students, but certainly we should obtain valuable indications as to what is right and what not quite so right with us. Follow-up studies are, of course, not uncommon but they are certainly not standard practice.

The second major role of a teacher college is what may broadly be termed research, term which I use to include such activities as textbook writing, preparation of teaching materials and the like. In few colleges are research activities really built into the working pattern of the institution. Rarely do we define what status research is to have *vis-a-vis* the former functions of our institutions and only a small and highly favoured number of colleges provide financial assistance for research. Consequently the normal pattern is for individual members of staff to select research topics according to their personal inclinations and to pursue them in isolation as a spare-time activity. The consequence is too often a waste of time and effort: many projects founder unnoticed, other splutter along for years without getting anywhere; some are completed, written up, and attract passing notice; few indeed make any worthwhile contribution to the solution of our problems. Major fields of inquiry are neglected because they are beyond the scope or capacity of the individual researcher or demand time and resources not available to him. Often the nature of the research being conducted is not known even to the researcher's colleagues and the likelihood that the project will be duplicated in another institution is considerable.

Research is a vital aspect of our work in teacher colleges and that we are in danger of wasting valuable opportunities if we do not encourage lecturers who engage in research activities both to make use of their experience and front-line situation and to improve their professional competence. But it suggest that in our present circumstances, when resources are scarce, when senior staff are heavily burdened with routine duties, and when competent supervision and advice is not easily available, we need to adopt a far more systematic approach. The projects should thereafter be conducted co-operatively by the staff of the college with outside specialist assistance as required, and the work should be carefully planned into the general work of the college. Steps should be taken to ensure that the nature of the research is widely known so that the interest and assistance of other individuals and organizations may be encouraged and to promote collaborative research rather than duplication of effort. Finally the research should be systematically and regularly evaluated and reported. I would not entirely exclude individual research projects conducted outside the college programme but I would suggest that as far as possible effort should be directed towards the attainment of the planned foals of that programme.

If we rarely define out institutional goals and provide for adequate evaluation of our success in reaching them in such areas as teaching and research, even less frequently do we do so in connection with the third major area of work in the college-administration. Clearly this is a different and secondary level of activity. Administration is not pursued as an end in itself but exists to facilitate primary level activities and indeed there is a tradition in many of our educational systems that administration is not a specialized activity but one which may be carried on incidentally by those

responsible for the primary functions. However, as our institutions have grown, administration has become far more complex and increasingly has crystallized as a distinct field of activity. Regrettably this has sometimes led to a polarization of staff. The teaching staff of our college are not usually slow to criticize their administrative colleagues and vice versa so that tension between the two have become almost a standard feature of academic life. Yet we rarely define the criteria which we are using in passing judgement on the administration and even less frequently do we examine the goals which are implicit in the criteria we use; consequently our criticism tends to become inconsistent, sectional, and petty. At the same time one may discern a tendency in those who are charged with administrative responsibilities to over-value the smooth running of their own routine operations and to lose sight of the primary goals of the institution. One reason for this is the lack of a frame of reference common to both academic and administrative staff by which the actions of both may be judged. Without such a frame administration tends to become bound by decisions and precedents established on an *ad hoc* basis and by sets of procedures which may or may not contribute to the maximum efficiency of the institution as it evolves and changes through time.

What kind of goals are appropriate to administration? One must certainly be to provide clear and speedy channels for exchange of information between teaching staff, administrators, and students so that all are provided with or have access to the information and material they need to do their work. Allied with this would be the maintenance of channels of communication in order that problems may be brought to the attention of the appropriate authority and attended to before delay complicates and magnifies them, and so that action taken and the reasons for the action are

understood by all concerned. A third goal would be to determine and regularly review the allocation of responsibility and the decision-making structure, and to ensure that this system is understood and used.

The optimum utilization of plant, materials, and staff, effective liaison with ministries of education, schools and other educational institutions, the maintenance of records in a form which will enable them to be used conveniently for prescribed purposes-these are further goals and the list could be lengthy. But what is necessary is for the key goals and the priorities to be clearly established and defined, and then for the machinery through which they may be attained to be designed, in the clear consciousness that it is the goal not the machinery which is important and enduring. If, as has been authoritatively suggested, education needs a managerial revolution, it is only on such a basis that changes can be validly affected. Evaluation of the success of particular patterns of administration will essentially be a matter for subjective judgement by all affected by their operation and it is likely to be impractical to reach collective judgements except in a piecemeal way, as when a board of studies, for example, reviews a particular operation such as teaching practice or when a governing body dissects the annual estimates. But at least these judgements will be formed on the basis of clearly, understood common goals and many of the frustrations which arise from preoccupation with irrelevant goals may be avoided.

It is perhaps in such ways as these that we, in teacher education, may initiate a process of intensive and disciplined rethinking such as I am convinced we need if we are to innovate and evolve purposefully. We have a responsibility to the societies we serve to ensure that we are as efficient in fulfilling its general objectives as we can be and we have a responsibility to ourselves to

ensure that our skills and labour are not wastefully employed. We have achieved a great deal in the past decade but the time has come when consolidation and re-examination is vitally necessary if the foundations on which we shall build in the future are to be capable of bearing the load.

Any idea that the educational administrator is to be differentiated from the educational planner is to be discarded; work may be specialized and there may be specialists but every decision taken in a decision for the future and a chief education officers over the years are likely to be judged by their success in meeting the needs of the body politic that appointed them it behoves them to consider how those needs can be met. Nevertheless it is true that the future manpower requirement is a dominant element in the planing of education. Even where individualism or personal predilection is supreme the majority opt for the sphere in which the chances of economic well-being are good, that is a sphere in which a shortage is likely, and the providers of schooling must plan for a demand in that direction and for teachers able to teach according to the predicted requirement. Evidence of where those shortages are likely to occur is readily available, through statements appearing in the press and elsewhere, and can be interpreted by anyone, be they pupils or planners, with a will to do so. That evidence can be supplemented by all the techniques of the manpower surveyor and projector; administrator-planners may be rightly expected to seek the supplement and many countries have the supplement available. But even then the decision is one of art rather than of science.

Even if personal predilection is curtailed and a capricious element is thereby removed from the problem, there still remain variable factors such as those assumptions necessarily made about the growth or recession of the economy involving many further

questions of internal investment, the strength of commodity markets, and such like imponderables which are known to exist, but to exist within limits which can still be assessed with some, but diminished, confidence. But there are likely to be unknown factors which will emerge during the period of any plan for developing education-factors such as war, or pestilence, or the discovery of mineral resources, or invention-which gravely affect any plan which is rigidly treated as valid. In any case, as Professor Harbison later said, it is 'often just as logical in national planning to start with a broad plan or strategy of development and utilization of human resources as to begin with a plan to maximize economic growth. In other words, one might argue that economic planning should be integrated with human-resource planning rather than vice versa.

Even if the task of the educator is limited to meeting the requirements of a rigid plan rather than devising it, he may still fail. There can be failure from poor teaching or bad selection or, put in more theoretical terms, because there is only a meagre correlation between the input (what is put into schooling) and output (the capacity of the school-leavers). For this reason, and for the reasons set out in earlier paragraphs, it is almost certain that there will be shortcomings in any country's schooling system in relation to its need for men. **Some built-in elasticity is required.**

The International Institute for Educational Planning in its Report on Educational Planning in the U.S.S.R. said:

the answer to all the questions one may ask is not to be found in the strict planning of manpower requirements and specialist training. In this period of shortage, the solution to the major problems was found by using various techniques, namely concentration of effort on selected and limited targets, widespread use of out of school methods of

training ('on the job') and the hope, which proved justified to a large extent, that available manpower would adapt itself to the changes in the structure of the economy.

Notice that rigidity to elasticity so that 'targets' could be selected for concentrated effort and that out-of-school training was available to close the gaps. Notice, too, the current and perhaps quite proper concentration upon input by producing the men required (even if some of them are self-produced by adaptation) and the emphasis on the 'various techniques' that become involved in closing a manpower gap.

It seems clear that where there is any well-administered school system the number involved at any one time in any one gap are likely to be comparatively small. Secondly, the recipients of the new input of training/schooling must be selected with care. Thirdly, the extent and nature of the gap must be closely, for any overlap widens the input output gap rather than closes it and, finally, the gaps may appear in many and very varied forms and at frequent intervals. Most countries, and especially the developing countries, have had experience of short-lived training enterprises specifically designed to close immediate and critical gaps, but many other gaps, less critical perhaps but nevertheless important, have not been closed for the reason that there is no *continuing* organization for meeting the requirement; overcoming inertia is expensive of energy and even repeatedly overcoming inertia is not so satisfactory as sustaining an existing operation in being. The technical colleges and polytechnics of Britain are in being very largely for this continuing purpose as were the mechanics institutes of a former era.

The conclusions for administrations in educational work that must be drawn from the foregoing are first that literacy and numeracy must be inculcated at the earlier

stages of schooling so that, together with a later in drilled capacity to face novel issues with the aid of literacy and numerary, mastery of a fresh skill or body of knowledge can be confidently expected to result from a new input of education or training. Secondly, that the facilities to enable a new input to be invested shall be institutionalized to avoid the problems of major policy decisions whenever a gap appears; this is not achieved merely by establishing an institution-many are the underutilized technical colleges in the developing countries which, with more elasticity in their staffing, could (but do not at present) render the small but frequent gaps in input-output less serious. Furthermore there may prove to be a need for elasticity in methods of instruction-tutorials rather than lectures-and all places of higher instruction may find themselves involved in this situation-not merely technical college. Where this flexibility is impossible to find locally the call for overseas aid is well founded: to provide what is required immediately it is required, and for no longer that it is required.

There is one further aspect which is not one for the educational administrator to solve but one for him to mention when the existence of a gap appears to his discredit: there may be obstacles that hinder the proper outflow of talent from the reservoir of manpower into the work system.

Such an obstacle may arise, for example, from a customary usage that the appointee should be male rather than female and custom may have become rigidly entrenched by statute. Nearly unalterable 'establishments' of personnel and pay scales are similar hindrances to matching input and output as are the outmoded usages of a trade or profession which have arisen in the past and are enshrined in the present. Flexibility is not only desirable in the input but also in the requirements of the

country-the gap is not always to be blamed on the educator.

But there is a much more cogent reason for urging elasticity in the provision of education and training than has been set out in the previous paragraph. Those paragraphs are concerned with a situation all too commonly expressed in relation to economic development: that education is required to meet the manpower requirements resulting from progress (if, indeed, it be 'progress') and that if those requirements are not met the resources that have been invested in development projects will be wasted or partially wasted. It is, of course, true that capital investment from external sources will not be made unless there be suitable manpower available or readily made available (which in another way of stating the reason for elasticity in preparing men) but the mainspring for development is manpower itself and not capital (important though it be). The word 'manpower' is not confined to human *labour* in the narrow sense; it comprises also humans with entrepreneurial skill, idea, perception, and energy.

The best available figures suggest that the amount of capital required per unit of output can *fall*: this does not support the fashionable view that growth of output depends upon further investment... Recent evidence from a number of countries suggests that additions to investment have yielded disappointingly small additions to output; the conclusion therefore seems to be that the rise in productivity has been predominantly due to 'human factors', better knowledge, organization, skill, effort, education, enterprise.

Human qualities of the sort described are not likely to be mass-produced by any monolithic school system with a rigidly imposed regimen unless there are also available some facilities whereby an individual or a few

individuals can develop their innate qualities. it is difficult to recognize even potential qualities of this nature if the school routine is stereotyped. There must therefore be room for individualism in the school. Even so individual qualities may remain dormant for ever unless an elastic system of further education is also available. The economic imbalance and the consequent economic striving to restore equilibrium, caused by innovation is a prime cause of 'progress'.

It is not the purpose here to present an impassioned appeal for the greater use of audio-visual aids in education, to extol their virtues and value in the classroom, nor to review the whole range from chalkboards to television and computer-assisted learning available to teachers and to education generally. This has been most ably done already by such authorities as, for example, Helen Coppen in *Aids to Teaching and Learning*, C. J. Duncan in *A Survey of Audio-visual Equipment and Methods* and Len S. Powell in *Communications and Learning*. Nor do I propose to examine and compare specific pieces of audio—visual equipment and offer technical advice on their operation and maintenance—such information can be readily found in teachers' journals, *The Times Educational Supplement*, and in the periodicals and other publications of such specialist bodies as the Centre for Educational Development Overseas, the National Committee for Audio-Visual Aids in Education and the National Council for Educational Technology.

Because audio-visual aids, educational technology, or whatever else may be the currently acceptable term cannot be discussed in isolation, my aim is, rather, to look at some of the general educational trends which seem relevant and about which people are talking and writing in Britain at the present time in the hope that this may enable interested people to consider—as do the

experienced teachers from overseas who come each year to take the diploma course in the theory and practice of audio-visual aids at the Institute of Education in London—what relevance these ideas and activities may have to education and to teacher education in the developing countries in which they are working.

Education is for change. 'Education and training face a challenge born of increasing numbers, rising aspirations and rapid social and economic change.' But the form and methods of education itself are also beginning to change. Child-centred education, 'which places the child himself as the very centre of the educational process, which regards him as an individual with inalienable rights of his own which must be respected by the educationist, and which makes his growth and development—both as an individual and as an acceptable member of society—the main aim of education', has been largely accepted at the primary levels and its implications are beginning to be felt at the secondary.

What is this 'educational technology' term which has comparatively recently come to the fore and is now to be found in many of the writings on both the theory and practice of education? Kenneth Richmond in *The Concept of Educational Technology* has assembled extracts from more than fifty sources and lists some 180 authors in his index, while Michael Eraut and Geoffrey Squires in *An Annotated Select Bibliography of Educational Technology* have brought together about one thousand items, classified under sixty-three heading, which include references to research, catalogues, and bibliographies. Clearly the technology of education involves both traditional and contemporary resource—books and chalkboards, pencils and paper, slides and tapes, film and television. But it involves much more than just the 'hardware' and 'software'—the audio-visual equipment and the materials needed to use with it—it includes

decisions about the educational ends to be achieved and decisions about the size of the learning groups, the learning sequence, and the and the choice of media.

There seems little danger that the teacher will be supplanted by machines and early anxieties on this point appear ill-founded. Indeed 'the point has now arrived where the teacher is still a dispenser of information but in addition he has become a creator of all kinds of learning experiences and the manager of a range of resources inside the classroom', and his already complex role 'will undoubtedly be further extended and developed as the application of educational technology in the schools becomes more widespread. Activities such as planning, advising, and evaluation will be among the teacher's chief concerns.'

His developing role as a manager has been explored in a symposium edited by George Taylor who points out in his introduction that the teacher has no monopoly of the art of exposition, of knowledge to be conveyed, or of the ability to show others how to acquire skills. His expertise lies in the devising and organizing of the learning process, in relating it to the needs of particular children, in giving help and support when, and only when, it is necessary. By accepting courses prepared by teams (including teachers), by permitting various technological devices to take over the work they can do—without boredom or impatience—as well as or better than the teacher, by encouraging the integration of educational technicians in the rooms where learning is taking place, the teacher is multiplying his effort and deploying it where it is most needed.

What are the implications in terms of teacher education? In initial training, practice varies considerably from college to college but Sandra Edwards suggests that most of them have ideas in mind similar to those of a

Scottish College of Education's three-phase course designed: (1) to provide an understanding of the mechanics, capabilities, and teaching potential of most of the aids in the audio-visual field; (2) to provide individual practical exercise in handling all major forms of equipment and to assist understanding of the capabilities of visual and aural aids; and (3) to promote an attitude to aids where regard is paid to the integration of a variety of audio-visual approaches in the context of teaching procedure.

The objectives at Coventry College of Education have already been quoted. In March 1970 a purpose-built Resources for Learning Centre was opened there where a whole range of resources (teaching and learning facilities, equipment, audio-visual materials and closed-circuit television) has been organized. The head of its New Media Department, Hugh Williams, says that, since teachers and student teachers have to make frequent decisions about which techniques, materials, and other resources to apply in solving particular teaching problems, the first aim of the new Centre must be to familiarize student teachers with as many of these alternatives as possible, so that conscious, informed choices can be made. Each year some thirty-eight groups of about fifteen students each follow a 20-hour curriculum course on the use and organization of resources in schools, in which emphasis is laid on the integration of materials and techniques in the classroom from the point of view of learning by the child rather than teaching by the teacher. The Centre also offers a whole range of materials and facilities which can be borrowed or used during teaching practice, or for the creation of students' own teaching materials.

While a basic familiarity with the existing range of audio-visual devices and an introduction to the concepts of educational technology may be given during initial

training, the results of technological advance cannot be applied to education without the full co-operation and involvement of the experienced, practicing teachers who make up the bulk of the teaching force. Many of them may not have had much more than 'chalk and talk' during their own training and for this reason opportunities for further 'in-service' education are essential. Such in-service education is being provided in many different forms, and it is only possible here to cite an example or two to indicate the ways in which teachers' professional competence is being developed.

The city of Bradford, for instance, has a Teachers' Centre, which began back in the mid-1950s, and recently moved into new, more spacious premises. Its principal concern is with the in-service training of teachers and work on curriculum development. Under the day-to-day direction of the Education Authority's Adviser on Curriculum Development, it is open from 9.00 a.m. to about 9.00 a.m., Monday to Friday, for the use of teachers and retired teachers. It provides a meeting place for some twenty teacher organizations; over fifty subject panels or working parties on various aspects of the curriculum, mainly organized and sustained by practising teachers, use it as a base; and about sixty people come each day to take part in working discussion groups. The form of 'In-Service Training' courses is changing and passive audience have been replaced by active groups of teachers interested in particular areas of the curriculum, testing their ideas in direct confrontation with others teachers. Where formal courses are still being run, they are usually only to give further instruction in a particular subject where debate or discussion on content or method might serve no useful purpose, e.g. servicing of tape-recorders. The Centres's resources include a loan library, a classroom textbook collection for reference, films, filmstrips, filmloops, overhead transparency sets, and multi-

media kits, as well as reprographic equipment so that any teacher can have materials copied and reproduced. Among its other facilities are a General Workshop where twelve people at a time can make their own teaching apparatus in cardboard, wood, and similar materials, a Maths Centre for groups of teachers which covers the entire range of mathematics and primary science, and a Home and Workshop Crafts Centre for lecture, demonstration, and workshop sessions for the whole range of creative home-making, art, and handicrafts. Under a new scheme two seconded teachers have been appointed as research assistants at the Centre in Maths and in Home and Workshop Creative Arts and Handicrafts, and they have enabled curriculum development work in these subjects to proceed at an increasingly rapid pace.

Moving from urban provision to in-service education on a more dispersed, county scale, the Visual and Aural Aids Service of the Essex County Council Education Committee has its roots in the Country Film Service established in 1939. Today it has a staff of twenty-eight and three broad functions: (1) the design, purchase, maintenance, and repair of equipment; (2) the provision of some of the 'software' which schools could not be expected to provide themselves; and (3) training teachers in the use and application of apparatus and in the production of teaching aids wherever possible. These three functions are considered to be complementary—teachers are better off without equipment if they are frustrated by its inadequate performance or unreliability. On the other hand, the finest equipment is of little use in unsympathetic hands. The problem of communication, the difficulty of getting information to the teacher in the classroom about the services which are available remains still unsolved. Circulars may sometimes fail to circulate, and notices posted on the staffroom notice board seem

sometimes to remain unread. An official list of in-service training courses does not always attract sufficient candidates to make a course worthwhile, and yet there are always teachers who would like to attend courses. In recent years it has been found more satisfactory to carry out basic training in equipment techniques in the schools themselves, usually after 4 p.m.

A full-time seconded teacher is employed in the department for this work, and spends his time in schools advising on the purchase of equipment and on its use. Most of the basic training is now done in this way, but more advanced techniques such as photography, film-making, advanced tape-recording techniques, and television production are organized at the Visual Aids Centre, or, in some cases, in a regional education centre. Every opportunity is taken to provide lectures at local refresher courses. Basic in-service training course within the Inner London Education Authority are now also decentralized and arranged in schools, colleges, and teachers' centres in response to requests from the teachers themselves. Thus, at the request of a head, the whole staff of his school can be provided with a 'familiarization course' outlining the principles of educational technology and demonstrating the use of modern aural and visual aids; eight or more teachers can organize themselves into a training group and ask for a 'technique course' to be given them on how to operate specific aids and use them in a variety of teaching and learning situations; and individual teachers can be given help in making materials in all media, from 8-mm loop films to synchronized tape/slide programmes, on 'materials courses'. Two series of weekly programmes on educational technology have also been produced for showing on the I.L.E.A. closed-circuit television network and, from September 1971, these are being related to many of the decentralized basic courses organized by local

multi-purpose teachers' centres. Practice kits and information leaflets have been produced to accompany the television series, the first of which examines various aspects of audio-visual aids, including programmed learning, projected and non-projected aids, modern reprography, sound recording, radio, and television, while the second is concerned with the management and organization of resources for curriculum renewal.

We have now examined some of the ways in which teachers are being helped to become more familiar with modern educational aids, trained to handle equipment competently and encouraged to create teaching materials for themselves. We have also touched upon the changing educational context to which these new communication skills and technological innovations can contribute—child-centred education, discovery methods, large group teaching, and self-pacing individual learning. In *Resources for Learning*, L. C. Taylor, formerly headmaster at Sevenoaks and now Director of the Nuffield Resources for Learning Project, is mainly concerned about methods of learning in secondary schools. He reviews experiments and developments in America, Russia and Sweden, as well as in Britain, and argues that we should test independent learning thoroughly as an alternative method to teacher-based learning. If education is to move increasingly towards such goals, not only must our teachers be effectively educated in their profession but they must also have adequate support both technically and in terms of resources upon which they and their pupils can draw.

The provision of resources for individual and group learning formed the main theme for the 1971 International Audio-Visual Aids Conference held in London, during which the Inner London Education Authority provided a prototype library Resource Centre for a Secondary school, in which a range of print and

audio-visual material, and the necessary equipment and services from professional librarians and audio-visual assistants were accessible to teachers and pupils. Traditionally books have been the main source of information but with an increasing provision and use of audio and visual aids by both teachers and children, schools are beginning to find that some central organization of these resources within the school is becoming necessary. The library has been the place where books have been housed in the past and what is being suggested within the I.L.E.A. is that these new resources for learning such as slides, tapes and transparencies should logically also be stored there so that they will be equally accessible to individuals, groups of students, and teachers.

Thus the library/resource centre is a focal point of learning and research—a work area providing a variety of opportunities and materials for teachers and taught. It is therefore seen as a complex of spaces where various sized groups can study. It should provide first class facilities for large group listing and viewing; opportunities for discussions and seminars using all forms or resources, and facilities for independent study of print and non-print materials. In addition to storage and retrieval facilities it must also have spaces for the production of materials by teachers and assistants, and it must also have the appropriate professional support staff.

While the library/resources centre within a school or in association with a group of schools can provide a focus and source of reference of reference for children and teachers there, it is likely that, however competent and knowledgeable the professional personnel who staff it, there will be times when help, advice and resources will have to be sought elsewhere—such a centre cannot easily exist in isolation and will itself need support. It is true that as more learning resources become available,

and any associated equipment increases in quantity and complexity, more advice and services must be available to the teacher to assist him in becoming aware of their existence, in choosing those most appropriate to his needs, in producing resources to meet specific requirements, in employing them successfully in the classroom, and in developing ideas and techniques of his own.

What should be the role of an education authority in such a situation as this? In order to provide some guidance to any local education authorities who may be considering how best they can help their teachers to make effective use of the bewildering variety of audio-visual resources which are now available, the members of the Central Committee of Advisers in Audio-Visual Education and the Central Committee of Teachers' Audio-Visual Aids Group have prepared a booklet entitled *The Organization of Audio-Visual Resources for Learning in a Local Education Authority*. In it they suggest that, if teachers are to get the kind of help and support which they need, an audio-visual resources service has to be provided with an audio-visual media adviser for the authority's professional staff, an audio-visual resources centre to assist teachers, and appropriate audio-visual resource organizations within the schools and colleges. After discussing the role of the adviser, the booklet goes on to consider in more detail the function, staffing, and siting of the type of Local Education Authority Audio-Visual Resources Centre which they recommend.

What has been attempted here is only to indicate some of the ways in which audio-visual aids and educational technology are being incorporated within the changing educational pattern in Britain. In assessing their relevance to the needs and conditions of other countries with different educational structures and administration, much may depend on the climate of opinion prevailing

not only among the educational planners and policy-makers but also within the rank-and-file of the teaching profession itself; problems of repair and maintenance may be more acute in non-temperate climates and where a technically trained and oriented layout force has not yet been created, particularly where equipment and spares have to be imported from overseas; inadequate supplies of 'software' may also be a limiting factor—it has been suggested that in Bradford it requires about 3 a week to keep an overhead projector going if correctly and fully used and about pound 5 a week for a film projector.

The model for analysis of the research results in the regional reviews was derived from an attempt to identify all possible teacher-related variable that might be associated with changes either in "the teaching situation" (teacher-student interaction) or in students, schools, and community.

Thus for the purpose of this synthesis it seemed convenient to group the results in the following way:

- (a) "Factors" (teacher background and school system variables) as they related to the "teaching situation";
- (b) "Teaching situation characteristics as they relate to outcomes; and
- (c) "Factors" as they relate to outcomes. Figure I illustrates the way to which the various sets of relationships were postulated, with effectiveness defined in terms of the association between factors (determinants) and intermediate and final outcomes.

Before looking at the results themselves, it will be useful to explain some of the terms used:

- *Teacher effectiveness* is loosely defined in terms of the changes which take place in the knowledge, attitudes, and behaviours of individuals and communities as a result of teacher involvement.

- *Teaching situation* is made up of the behavioural and attitudinal characteristics of teachers and pupils and their interaction of an educational setting.
- Factors refer to those personal and professional background conditions that a teacher brings to the teaching situation which might affect its character. They include other influences such as the school and social system, as these affect teacher characteristics.

Outcomes are those pupil changes in achievement, attitudes, and behaviour that take place in the context of the teaching situation, as well as the institutional or community changes that are due to teacher involvement.

Not all the variables suggested in the framework were found to be covered by the research reviewed under this heading. For example, there were no studies that dealt with effects of the social context in which the teacher operates, except for some differences noted between teaching in rural and urban schools. Results of the available studies can thus be grouped in two set:

- (a) Teacher factors: sex, age, personality, socio-economic status, knowledge, ability, language, instruction, attitudes, experience, qualifications, and training.
- (b) School system characteristics: location of schools; types of school management, subject matter and level taught, resource and social status of teacher.

A number of studies comparing male and female teachers, for the most part in secondary schools, found that female teachers were more satisfied with their career, possessed a better attitude toward the profession, students, and school work, exhibited better mental health and suffered less from problems related to their teaching activities. Females appeared to have a better perception of an open school climate and this in turn appeared associated with better job satisfaction. Although there did not appear to be a clear relationship between sex and

teaching attitudes, there was some indication that female teachers use more "modern" teaching approaches such as participatory, problem-solving methods and in the case of student teachers, females performed better. The results do not clearly affirm the superiority of female teachers as there are studies that reach inconclusive results and others that contradict the ones above. There was no research of this type in the Malaysian, Philippine or African reviews.

Not much research related age to teacher performance, but a few studies did indicate that teachers in the 30 to 40 age bracket showed greater job satisfaction than younger or older ones. Teachers in this age bracket also appeared better adjusted, with a better knowledge of educational principles and a better educational attitude. A few Indian studies pointed to a relationship of age to teaching skill and of younger teachers to the use of "indirect" behaviour.

By far the largest number of studies relating personality traits and needs to teacher skills and behaviour was found in India. The range of personality traits described is large and makes it difficult to move beyond generalizations. Relationships were reported, for example, between traits of being self-sufficient, venturesome, initiator, resourceful, outgoing, and extrovert and rated effectiveness, teaching skills, and indirect behaviour; also a relationship was noted between social and personality adjustment and rated teaching efficiency. Emotional stability and extroversion appeared related to effectiveness in these Indian studies, but this was not the case in Zambia where extroversion was related to mediocrity or failure in classroom teaching of student teachers. A relationship between personality traits and classroom performance was also noted in the Middle Eastern and Philippine reviews. De la Merced's careful study found "control" positively correlated with

teaching attitude and absent-mindedness and tension negatively correlated; intelligence and conscientiousness positively correlated with teaching efficiency and timidity and tension negatively correlated.

Much less is said about the impact of socio-economic factors on teacher performance. There was some evidence of a relationship linking sex and SES with job satisfaction: males in the upper socio-economic groups were less satisfied than females. The same sort of relationship appeared with respect to perception of classroom discipline where males of the upper socio-economic groups appeared less patient than females. A positive relationship between socio-economic status and teaching skill was reported in India; other studies also showed a relationship between various SES indices and motivation, and a negative relationship between these indices and attitude. A non-significant relationship between SES factors and teacher behaviour was reported by Indian researchers and by a group of Thai researchers in respect to self-confidence in teaching on the part of student teachers.

Some indication of a relationship between intelligence and ratings of teacher performance was found among elementary teachers in the Philippines. Several Indian studies reported a relationship of intelligence to performance among secondary teachers, but others reported neutral findings.

Also in India, teacher aptitude was found related to teaching skills and indirect behaviour. Creative thinking and its effect upon teaching skills and indirect behaviour was examined by Gurbaksh and Mathew in India but results were inconclusive with some indication of positive effects upon indirect behaviour.

Practically nothing was found on the effects of language of instruction upon teaching behaviour, except

for a couple of studies in India (both of unsatisfactory quality).

A few studies related teacher knowledge to performance. A Nigerian study found pre-service grades of secondary teachers to be related to knowledge of subject matter and educational principles but not to classroom behaviour described in terms of communication skills, promotness and attendance; however, another African study did find a relationship between grades in teachers' college and classroom performance of elementary teachers, and a similar result was found in India.

A set of studies in Thailand reported a positive correlation between scholastic achievement of inservice trainees in different subjects and their ability to teach hill-tribe children. But another Thai study did not find any relationship of this type among English major student teachers. In India, there were a few studies that reported a relationship between knowledge of subject matter and teacher efficiency as rated by students.

Teacher attitudes towards educational, political, social, and religious issues and their effect on the teaching situation was hardly looked into. Only in India were there any studies of this type. Teachers' attitudes to educational aspects dealing with teaching, teacher-pupil relationships, discipline, teachers, pupils, homework, curriculum, teaching-aids and management were found to affect classroom behaviour in relation to these aspects.

Teacher attitudes in favour of political democracy were found related to "indirect" behaviour, and democratic and "social" attitudes such as those termed unbiased, progressive, sympathetic and friendly were found related to teaching efficiency.

Teachers are viewed by the community in a

multiplicity of roles and research confirmed this assumption. Consensus on role among colleagues, students and principals was found to contribute to a teacher's job satisfaction and, in turn, role anxiety related to ineffectiveness. However, with one sole exception in which teacher perception of himself as "director of learning" was found to be related to effective behaviour, no studies showed how differences in role perception could affect a teacher's behaviour and attitudes.

School system

The impact of the characteristics of a school system was mostly investigated in relation to teacher attitudes. It was found, for example, that the location of a school affected teacher attitude toward teaching of mathematics in elementary school and that authoritarianism was an attitude of teachers in rural areas in some Latin American settings. It was also found promoted favourable teaching attitudes; that subject matter taught affected attitude to teaching as did the school level. Teachers of younger classes showed better attitudes to the teaching profession than those of higher levels; the same was the case regarding attitudes toward students: the better ones were those of teachers in younger classes. In the Philippines, however, teaching at this level was related to a greater number of professional-type problems.

Some effect of school system variables on teacher behaviour was also reported. Location of schools was found related to practice-teaching behaviour and to lesson planning in adult literacy training; in one case, practice teaching in village schools appeared more beneficial than that carried out in town schools. In India, convent school teachers showed a positive relationship to most components of indirect behaviour; headmasters did not differ in their attitude toward work-education from assistant teachers, type of institution was not related to

job satisfaction, nor was the place of posting related to attitude toward students. Also in India, lack of teaching aids and library resources was linked to inefficient teacher behaviour. In respect to subject taught and teacher behaviour, Malhotra found that science teaching was linked to indirect behaviour while art was not: that subjects chosen by student teacher as opposed to those imposed on them produce favourable attitudes toward teaching was the conclusion of another study. The examination system in India was reported to be negatively related to teacher behaviour as was heavy syllabus, additional workload and lack of teaching aids. Teacher satisfaction with the curriculum was found related to the indirectness ratio of primary teachers.

Finally, with regard to job satisfaction it was found that incentives such as recognition, advancement, and interpersonal relationships contributed highly to it, while policy and administrative factors, low salary, the nature of work, and the social status of teachers die not. Teachers' morale, presumed to be related to leadership qualities of school principals, was found to be positively related only to principals' qualifications.

The effect of pupil characteristics on teacher performance or attitudes was barely investigated. Only one study reported that lack of initiative to learn, together with class size and low income negatively affected teacher performance.

Experience and training

Experience. What perhaps appears more clearly from the reviews is that there is some positive effect of length of experience upon the type of techniques used in the classroom; the evidence, however, is limited and even contradictory regarding what type of techniques are associated with different levels of experience. In fact, a number of studies reviewed in the Middle East point to

the use of a participatory, less authoritarian type of teaching, which includes problem-solving and discussion methods as being associated with teachers who have somewhere between 10 and 20 years of experience. A similar finding is reported by Bhatnagar. Ozumba also found that the same period coincides with a greater commitment to the teachers' instructional role and the tendency to follow the expectations in this regard. Beyond this period, teachers move away from their expected role. On the other hand, the study by Swet reports an association between experience of less than five years and the use of participatory and less authoritarian techniques. With regard to teacher attitudes toward student and teaching, they either do not appear related to experience at all, or to experience beyond 13 years. However, Gayatri reported a positive relationship between maturity of experience and attitude toward students and work in the school.

(b) Training. A first question here is of the relationship between training (whether academic or professional) to teaching behaviour (attitudes, knowledge, job satisfaction, and personal adjustment, as well as teaching styles and mods of interaction). Generally speaking training does appear to make a difference with regard to some aspects of teacher behaviour. Teacher attitudes were found to be affected by training in a number of Indian studies, use of more authoritarian pupil control methods was reported for untrained teachers in Iraq; in Sierra Leone training was found related to indirect style of teaching, better preparation of lessons and to the quality of professional relationships.

What was not so clear was the effect of higher levels of training or qualifications, such as university versus teacher college training, or more years of study or better

achievement during training. Here there are contradictory results. In one group of studies, higher qualifications appeared related to positive attitudes toward teaching and toward the profession; higher qualifications were also related to the use of various classroom techniques characterized as indirect, participatory, and employing modern aids and inquiry procedures. Conversely, other studies, though recognizing the effect of training, were not able to suggest that higher qualifications or graduate training were better than lower levels of training. There was indication that if a teacher is less qualified, he or she feels happier in the profession. A few studies even pointed to no relationship between training and classroom performance. This finding is particularly interesting as two of the studies that support it were considered by the reviewers to be exceptionally good ones and of ample coverage.

Most of the studies relating qualifications and training to teacher behaviour and attitudes were carried out at the secondary level.

Some work has been done on the effect of various methods used in pre-service teacher training. A number of these have to do with the impact of microteaching on student teacher behaviour, type of questioning, use of participatory methods, and use of visual aids. All but one report positive relationships between this type of training and classroom performance of student teachers. One of these studies reported an interaction between experience and microteaching; student teachers who had more than one year of previous experience profited most from a sequence of microteaching followed by macroteaching.

The introduction of simulation techniques into teacher training was examined mainly in Thailand where several studies showed these to be superior to traditional techniques of lecture and demonstration in the use of

participatory techniques and indirect behaviour as measured by Flanders' Interaction Analysis. Team teaching was reported in one study to be related to indirect behaviour. The use of interaction analysis in training was found related in Thailand to the development of a child-centred approach to teaching and training in indirect behaviour was found to affect its use in the classroom.

The effect of various feedback strategies on student-teacher behaviour was also detected in several studies. Positive attitude changes toward teaching were reported when feedback techniques had been used, such as pupils' observation and teachers' self-ratings.

Student teachers' personal adjustment was found related in a Philippine study to the use of preventive counselling for lessening of problems.

The relationship between inservice training experiences and teacher behaviour and attitudes was examined in a number of studies. Several of these reported a positive effect of inservice training on attitudes regarding teaching and subject-matter. A couple of studies, on the contrary, did not support this relationship. Another effect of inservice training seems to be in the area of subject-matter knowledge: of intermediate teachers in mathematics, in developing selected concepts in biology, chemistry, and physics and in physics and general science. Teaching methodologies and classroom behaviour were also found related to inservice training in several studies. In fact, when compared to teachers with only pre-service or no professional training, there was a positive effect on quality of lesson training and observed performance, on instructional skills and personal qualities, and on success in implementing curricular changes or reforms in the educational system. On the whole, practically all that is

reported on inservice training shows a positive effect on attitudes and teacher behaviour. However, given the number of inservice courses that have been organized in every country, some reviewers note the lack of studies on the effects of inservice training upon students, and especially of longitudinal ones that measure changes in teachers and students over a period of time. There is also not much evidence of the effectiveness of different ways of organizing inservice training or methodologies used for this purpose. An exception in this respect is a Thai study dealing with various means of performing inservice training such as studying from instructional pamphlets and listening to or rating audio-tape models.

The Teaching Situation as Related to Outcomes

Although the framework suggested a number of teaching situation variables that might affect pupil or community outcomes, the research reviewed centred only on a few: teaching styles or methods, teacher expectations, language of instruction, and effects of social and school system variables. There was practically nothing on the effects of pupil characteristics on the teaching situation and its outcomes, although several reviews reported studies on pupil characteristics per se.

Teaching methods

The majority of the studies under this category dealt with the comparative effects of the discovery/inquiry method and the expository (sometimes labelled conventional) method. Operationally there is a variety of definitions of treatments and characteristics of instruments for the measurement of their effects. Nevertheless, there seems to be a general trend to which these studies point: while there is no significant difference in the effects of the two types of methods on student achievement on the knowledge (and sometimes comprehension) level, the discovery/inquiry method seems to be superior at the higher levels of cognitive skills.

The interaction between cognitive styles of pupils, teacher method, and performance on tests of recall, comprehension, and application was measured by Kazembe. He found that with a guided discovery method pupil cognitive styles were a significant factor on recall and comprehension. Analytic pupils did better than non-analytic ones. Along similar lines, two studies compared inductive versus deductive methods and reported no significant difference in achievement. However, Lim indicated that the inductive approach seemed to have a positive effect on the pupils' cognitive style in dealing with high order thinking activities.

There were also attempts to compare a "meaningful" method (teaching for understanding) with a "mechanical" method (role, convention). Ali found that teaching for understanding is more effective for problem-solving in arithmetic at the 5th grade level. Similarly, Abdul-Malik reported that teaching for understanding in logic is superior in developing scientific attitudes and critical thinking. Ibe observed that the mechanical method was superior in immediate achievement while the "meaningful" method was better for retention.

There were also related studies: Patel, C. found that the project method is significantly more effective in the acquisition of language skills among students with high IQ, and Sagrasania reached the same conclusion for social studies and work habits. Gill and Prema K. also found that the activity method improved achievement in languages and science while Joseph reported for science that the type of activity, whether laboratory or demonstration, has no effect on knowledge, comprehension or application. Its only effect, as one expects, was on skill development. On the other hand, Orbeta found that the open laboratory was superior to the structured laboratory in developing critical thinking.

Misha, J. reported that the creative-based method improved ability to solve problems, to reason, and to comprehend.

Other methods compared were (a) lecture-problem-solving versus question-answer-problem-solving with no significant difference in achievement in physics; (b) objective-based versus conventional method with a gain in achievement in favour of the former at the lower taxonomic levels but only limited effect to stimulate and develop higher mental processes; this study was carried out in physics, while a former one by the same author found that an objective-based course destined to improve language skills not only contributed to acquisition of such skills, but affected overall academic achievement of the students involved; (c) cooperatively structured versus competitively structured mathematics teaching—the former leading to better affective but not cognitive outcome; (d) individualized versus group instruction in physics, significantly different in favour of the first and (d) community resources versus conventional method in home economics leading to significant gain.

A number of studies attempted to investigate the comparative effect of programmed instruction on achievement. In the studies that Dave reviewed, three indicated an effect of programmed instruction upon pupil achievement in algebra, one in geography and five others in different subjects. In Malaysia, Ellson and Koh found programmed instruction effective when used as a supplement to the teacher. Similar results were reached by Lino.

Studies on the effect of audio-visual materials and techniques are scattered and fragmented. At the preschool level, Chuenpattanapang compared a multimedia approach with the conventional approach and found that concept formation negatively correlated

with reading ability of the experimental group while no such correlation existed for the control group. Kongcharden studied the effect of 3-D objects on preprimary pupils and found that it makes a significant difference in categorical style scores, but no difference in other cognitive style scores. Jamrerksang also compared video-teaching and film-loops with live-teaching and found no significant difference due to method. Kaligaperumal, M. compared filmstrip effect with conventional teaching and found a positive gain in knowledge of geography but no difference in skills.

A number of studies compared different specialized methods of teaching languages, but they are language-specific, and cannot be synthesized.

Modes of interaction

Results here are mixed. On the one hand, a number of studies carried out in Latin America indicate that a democratic or permissive attitude of teachers is associated with positive student achievement and a smaller incidence in school retardation. In Thailand it was found that a democratic attitude stimulated creative thinking. With regard to "indirect" versus "direct" mode of interaction, Kilani found that students taught by the "indirect" approach achieved significantly better than those taught by the "direct" approach. However, in India there were less clear results. Only two studies considered to be reliable were found, both of them at the primary level, and they indicated a positive relationship between components of indirect behaviour and achievement in geography. The Indian reviewer considered nevertheless that the finding was not decisive, as other, although less reliable studies, indicated a balance between positive and neutral relationships regarding effects of indirect teaching over secondary school achievement in science, maths and physics. Likewise, although detecting a trend toward

association between achievement and socio-linguistic interaction, Celia Agudo de Corsico was not able to support the hypothesis of this association. Studies by Njorge and Johnson in Sierra Leone, Mbise in Tansania, and Suriyawong in Thailand found that no significant relationship existed between the mode of interaction and pupils' achievement.

Four studies on motivation indicated a positive effect on pupil achievement. Ipaye found that although praise was not superior to blame, it was better than vicarious reinforcement (such as ignoring) on student achievement. In a similar study, Bello found a positive relationship between praise and performance of Nigerian primary pupils in spelling tasks. Faloma also examined the effect of the most preferred and least preferred reinforcers on task performance in arithmetic. She found a significant difference between the two types and differences between reinforcement and no reinforcement, always in favour of the former. El-Naib found that the effect of praise or blame on achievement of primary school pupils was conditioned by the extraversion-introversion personality trait of the pupils.

A carefully designed study by Sabado investigated the effects of knowledge of results and token reinforcement of mathematics achievement of high, middle, and low ability primary children. Best results were obtained by the group given immediate feedback followed by the group with immediate feedback plus token reinforcement. Ojena reached the same results with secondary school children.

An important number of studies gone in India, all well designed and with careful operational definitions, investigated the effects of different types of questioning techniques such as question-answer-feedback-problem-solving approach, divergent-evaluative questioning,

broad questions with feedback, narrow questions with feedback, upon achievement. In a total of eighty-five relationships reported, only fifteen at the primary level and six at the secondary level were positive, while seventy were neutral. The regional reviewer's conclusion is that these results at least raise doubts about techniques widely acclaimed as efficient, and indicate the need for further research on questioning.

Teacher expectations

Studies dealing with the effect of teacher expectations on student outcomes point in the direction of the subjective or pre-judging attitude which teachers may evidence and which contribute to promote or fail a student. A study carried out in Brazil shows that the previous knowledge that teachers have about the degree of immaturity of their students negatively affects their promotion. Similarly, Bravo and Salas found a close correlation between teachers' subjective evaluation of pupil intelligence and the number of failures. In addition, teachers' opinion about parents (projected on students and vice versa) was found to affect students' failure. Similar results were arrived at by Barreto and Babini. Project SOUTELE in the Philippines found some links between positive teacher expectations and student achievement. Walker arrived at similar results. In Malaysia, Chiam observed an effect of teacher positive evaluation upon the students' academic self-concept which in turn was found to have effect upon achievement.

Language of instruction

Few studies investigated the effects of language. In the Philippines when English was compared with Tagalog in terms of mathematics achievement in grades 2 and 4, there was a slight but nonsignificant difference in the rural schools. Guzman found that the acquisition of mathematics concepts and proficiency in grade 2 were

not affected by language of instruction, and Villanueva-Logan found a nonsignificant difference in score of second year high school students in English and Tagalog version of a mathematics test. A set of well designed independent studies carried out by Tuy, Mogol, Esclabanan and Santos investigated the effects of Pilipino and English in the teaching of science and social studies in grades 1, 3 and 5 and first year high school. Results showed equal effectiveness of both languages in science and a definite advantage of Pilipino in social studies. In his study of Ugandan schools, Heyneman found that fluency in language spoken by the teacher was related to achievement.

Social and school system factors

One study reported a positive relationship between the possession of aesthetic and political values by teachers and the popularity of these teachers among pupils.

Few studies tried to investigate the relationship between school structure and student outcomes. Fonseca, found a positive association of student achievement and class atmosphere with "school tradition" (internal regulations, administrative problems, discipline, etc.) but no association with school bureaucracy or status of school personnel. Pillai found significant interaction between administrative-organizational and social-educational student environment variables in their effect on student achievement. Banerjee in India also found the Basic Type of secondary school better than the Non-Basic for promoting achievement in several school subjects. Lulla found that narrow and subjective examinations were associated with backwardness.

Studies dealing with the effect of teaching-job conditions on student achievement are scattered and piecemeal. Swett reported a positive relationship between student teacher ratio and student achievement in the

first grade and a negative relationship in the sixth grade. He also found a significant correlation between student/teacher ratio and years of experience as well as between student/teacher ratio and school slowness. This led him to conclude that achievement may not actually be related to student/teacher ratio but to those other factors. The ECIEL study in Latin America also showed an absence of statistical association between achievement and student/teacher ratio except for students of low SEC who did better in small classes. Juriah found a positive relationship between lighter teaching load and student achievement, while Fonseca found that the standard of living of teachers and the stability of school contracts contributed positively but not strongly to student achievement. Lulla et al. reported that the transfer of teachers had a negative effect on the achievement of students, that large class-size and outdated syllabae were related to backwardness in mathematics at the primary level and the unplanned curricula was related to overall backwardness.

Only three studies dealt with the relationship between school resources and student achievement. Isahak found that such relationship was small, while Dhian Chand and Lulla et al. found that lack of facilities, teaching materials and reference books contributed negatively to student achievement.

Factors as related to outcomes

Most of these studies related teacher background factors to pupil cognitive outcomes. They include studies dealing with personal characteristics of teachers, and characteristics of training, qualifications and experience.

In two studies dealing with personal characteristics of the teacher and student achievement, no significant relationships were reported. However, an Indonesian study reported that female teachers produce higher

achievement at grade 6 level. Likewise, Dave reported for India that female teachers were more effective in promoting pupil gains and that a positive relationship exists between student achievement and age of teacher. Dave also reported that personality factors such as emotional stability and popularity have a positive effect on achievement while authoritarianism and extravertism have a negative effect. Similarly, desirable personality traits have a positive effect on student attitudes and on student acceptance of teacher. Musa also indicated the following relationship between personality traits and student achievement:

- negative relationship between: (a) teachers' ascendancy and (b) sociability and female student achievement;
- positive relationship between: (a) teacher responsibility and (b) emotional stability and male student achievement;
- certain personality traits (emotional stability, extraversion, clamness, forgiveness) relate positively to student achievement.

Regarding socio-economic status of teachers, it was reported by Megendzo and Hevia that standard of living and stability of school contract of teachers are weakly associated with student achievement in certain subjects (mother tongue, social studies, mathematics) and that teachers of higher social background tend to get higher achievement of both high and low social status.

Teacher qualification variables

The relationship between student performance and teacher qualifications was investigated in a number of studies mainly in terms of the following qualification variables: teacher educational attainment and knowledge

(level of qualification), training (credentials and certification), inservice training and teaching experience.

As regard teacher educational attainment and knowledge (level of qualification), most studies indicated a differential association with student achievement. Beebout found a positive correlation between the percentage of graduate secondary school teachers and student academic achievement. He further found that increasing the percentage of teachers with higher educational qualifications has a strong positive effect on student achievement in schools with inexperienced teaching staff but does not seem to have an effect in schools with experienced teaching staff. Similarly, Juriah found that graduate teachers are associated with better secondary pupil performance in Bahasa Malaysia. Dhian Chand also reported a positive relationship between teacher qualifications and pupil academic achievement at both primary and secondary levels. The Bangkok Institute for Child Study also reported that teacher qualifications are positively related to primary school achievement in grade 1-4. The same trend is supported by two studies conducted in the Philippines. Vallente found a positive relationship between units in science and mathematics taken by physics teachers and student achievement in physics. However, units earned in chemistry and general science did have a positive but statistically nonsignificant correlation with student physics grades. Barsaga found that the proportion of teachers with graduate training, teaching experience, and teacher salary correlated significantly with the performance of students at the National College Entrance Examination. But with step-wise regression on all student community and school variables only teachers with graduate units were related to NCEE scores. There were, however, other studies that indicated no significant relationship between teacher qualifications and student performance. Isahak found

that median teacher professional qualifications are not significantly correlated with achievement of pupils at the primary level. Similarly, Sifuna and Heyneman found that there was no significant relationship between the degree of schooling of teachers or the performance in academic and educational subjects and achievement of primary school pupils. Zeidan also found that no sharp differences existed between achievement of classes taught by university graduates and those taught by graduates of teacher training colleges.

Studies conducted in Latin America ended with apparently contradictory results: the relationship between the teacher qualification variable and student achievement variables was negative in grade 1, positive in grades 4, 6, and 8 and neutral in the last grade of secondary school. This could mean that the teacher qualification variable has a differential effect depending the grade concerned. It also partially supports the hypothesis that if the teacher-student bond weakens along the school cycle, the teacher qualification variable fails to stay as a determinant of educational performance at the end of secondary school.

There were few studies that specifically related teachers' knowledge to student performance. While Lulla et al. reported that inadequate knowledge of teachers was responsible for pupil backwardness in mathematics, Lim found a nonsignificant relationship between teachers' level of science degree and knowledge of science processes and levels of pupil achievement in physics. Similarly, Mahmud found that the conceptual and factual knowledge of science of Pakistani teachers did not have much bearing on the knowledge of their students. It is most likely that such results may be attributable to the existence of a bracket of knowledge teacher must possess, below or above which a significant relationship does not hold.

The next qualification variable is teacher training (credentials and certification). Beebout found a negative relationship between student achievement scores and percentage of untrained teachers in a school (less or more than 10%). It was also pointed out that moving a school from the lower to the upper achievement group by "elimination of untrained teachers" amounts to about 8.8% increase in the per student cost of upper secondary education for the Malay medium schools. Attar also found that the achievement of students whose teachers had pre-service training was higher in chemistry and biology than the achievement of students whose teachers had no training. However, pre-service training made no difference in student achievement in physics. In a third study reported by Ellson "unqualified" teachers used conventional methods of instruction. Results in student achievement were significantly different in favour of unqualified teachers. The design of the study, however, raises questions about the interpretation of results as to whether they reflect an effect of teacher variables, a method of instruction variable, or an interaction of both. Another study by Raijiwala showed better achievement in physics of secondary students when taught by trained teachers as compared to teachers without specialized training.

The only study that considered effects of training experiences upon student achievement was a particularly good experimental study carried out in Nigeria. This study indicated that use of microteaching in training significantly affected teaching results as far as the achievement of students in mathematics and their participation in classroom activities was concerned.

The third qualification variable concerns teacher upgrading, i.e. the effect of inservice training. Considering the large number of upgrading programmes taking place in many countries, the human and financial

resources involved and the reliance of success of educational reforms on such programmes, it is rather disappointing to find very few studies relating this variable to student outcomes. A study in the Philippines dealing with the effects of inservice summer science institutes on students taught by trained teachers showed significantly higher scores in physics, chemistry, and mathematics, as well as significant improvement in attitudes toward science. Wahib, investigating the effect of inservice training on fifth grade student achievement, found that the effect is not significant in mathematics, nor on the knowledge level in science, but significant at both the comprehension and application levels in science. On the other hand, Schiefelbein and Farrel found a negative correlation between attendance of inservice course and student performance in Spanish and mathematics in the eighth grade. In another study in progress, Schiefelbein and Farrel analyzed the variables that discriminated among those 8th grade students as to reaching the last year of secondary school. The variable "inservice training" was 10th in importance among over one hundred variables, but it was the 6th in significance for students of high socio-economic status. Barriga showed that while inservice training affects teachers' knowledge, it does not affect the students' learning outcomes. These contradictory results raise many questions regarding the objectives of inservice training, the optimum time needed for a possible effect to reach the student level, and the measurement of student outcomes.

The effects of a short task-oriented training programme in the mother tongue, with emphasis on specific objectives and detailed activities was investigated by Dave. He found that compared to untrained teachers, trained ones produced improvement in pupils' language skills that affected overall achievement. A similar study

was carried out with physics teachers resulting in improved pupil achievement in recognition and recall, and to a limited extent, in higher mental process.

Concerning the relation between teacher experience and student performance, Magenzo and Hevia isolated eleven relations between these variables, found in Latin American studies. There were five positive, three neutral and four negative ones. The results showed a trend of association that did not stay linear in all grades and all areas of knowledge. In the early primary grades, there seemed to be a rather negative relation due to a promotion policy of more efficient teachers on higher grade. Toward the latter primary grades, the relation became constantly positive for the mother tongue, science, and mathematics. Towards the end of secondary school, teacher experience seemed to have a differential influence upon achievement in different knowledge areas. While the relationship remained positive in the field of natural science, it became neutral in the mother tongue considering the cultural and extra-scholastic influences on the student. Studies in Malaysia concentrated on the secondary level with contradictory results due possibly to the differential influence of teacher experience. While Juriah found a negative relation in Bahasa Malaysia, Lim reported a nonsignificant relation of teacher experience with overall achievement, while Beebout reported a position relationship as well as significant interaction between teacher experience and qualification in the sense that as qualification increases the importance of experience decreases.

Modernist Project in Education

Modernism takes as axiomatic that human beings have agency and through the application of reason, may work to improve themselves and the world. Habermas referred to modernity the endeavour to improve knowledge and to promote social justice as an incompletable project. This paper endeavours to show that the concept of modernity is still valid, and underpins the possibility of progress in educational practice. Usher and Edwards draw on the work of Lacan, Foucault, Derrida and Lyotard to promote the concept of postmodernity in education. The elusiveness of the concept of postmodernity is accepted by Usher and Edwards as part of the postmodern condition in which meaning is necessarily elusive and often arrived at through allusion. They declare that 'although it is customary to define what one is writing about, in the case of "postmodernism" this is neither entirely possible, nor entirely desirable'.

They present postmodernity variously as a precondition of modernity, relating Lyotard's view that '... postmodernism is no modernism at its end, but in a nascent state, and this state is recurrent'; a subversive challenge to modernity: 'the educational project in the modernist sense may be coming to an end in the displacement of modernity's claims by postmodernity' and as a successor to modernity, although not necessarily a welcome one. '... the postmodern condition allows a non-epic legitimization of knowledge to optimise the

efficacy of the system'. Even so, they admit their own modernist tendencies: 'It is not comfortable to turn away from the teleologies of emancipation and knowledge and the "security" of modernity when these frame so many of our own desires.'. Yet, so convinced are they that certainty and closure must be avoided, they cling to the concept of postmodernity and, following Lather, they believe that 'fears of relativism and its seeming attendant nihilism or Nietzschean anger, seem ... the implosion of western, white, male, class-privileged arrogance. They ask provocatively 'where the dream of rational control and total knowledge through science has led', and draw attention to the theorem that 'all science rests upon shifting sand' and that the reflexivity of modernity subverts the excessive claims of reason.

According to Usher and Edwards, all that postmodernity seems to offer education is a recognition of difference, through agonistic challenge and ludic parody. They see postmodernity 'loosening up' education, creating spaces for resistance and students' experience; 'giving local "voice" to the different and shifting knowledges through which the social formation is constituted.' None of this, however, implies progress for '... progress is no longer tenable'.

Lurking like a palimpsest in the position of Usher and Edwards, I detect a paradoxical grand narrative in which the status quo of education is seen as oppressive and to be subverted by constant questioning in the interest of uncovering and highlighting difference. This agonistic endeavour may be linked to a concentration upon language as divisive discourse in the writings of Derrida, Foucault and Lyotard. Young pointed out that "Derrida honours the other, Foucault honours the self, both effectively stumble when they reach toward the possibility of bridging the gap between persons". Lyotard based his analysis of contemporary knowledge on the

metaphor of language as game -'what is needed if we are to understand social relations ... is not only a theory of communication, but a theory of language games which accepts agonistics as a founding principle'; and he holds a pessimistic view of the splintering of language, holding that those within a particular game, such as science, may reach consensus, but that each game is separate from other people's. Even "in the ordinary uses of discourse—for example, in a discussion between two friends—the interlocutors use any available ammunition ... questions, requests, assertions, and narratives are launched pell-mell into battle". For Lyotard, human communication is a war.

An alternative, more communicative and convivial aspect of language use is ignored here because it does not sit comfortably with the thrust of the concept of postmodernity, and it is in recovering this aspect of language that we believe the critique of postmodernity lies most tellingly. This is particularly important in education where communities of people, drawn from different backgrounds, come together for a common endeavour. For some teachers and learners language use may be a war, in which games are played, including oppressive discourses of teacher power, and self-protecting games of student disaffection and revolt. However, this is not the practice in most classrooms, especially in post-16 education, where interaction is marked by the normal conventions of language use, although in ways that may need to become more dynamic and open in pursuit of the incomplete project of modernity.

Drawing on the work of Habermas, a distinction may be made between language used for the imposition of will through power and violence, and the potential of a common will formed in non-coercive communication. It is the case that much interaction in education is based on the former. However, the latter is possible and desirable.

The Juggernaut of modern experience

Lyotard's work is valuable in increasing scepticism about grand narratives of emancipation and progress. 'Progress' has been made by some people but at the expense of others and a high price has been paid in ecological damage, yet it does not follow that we must abandon the endeavour to progress, in agreed human terms, while adopting a more reflexive and critical stance. Similarly, the work of Foucault, in exposing the genealogy of power discourses and the way at dominant interests (often western, white, male, middle class) re adept at obtaining and retaining power, is valuable, but it does not follow that the modernist project of humanistic progress should be abandoned because that endeavour has been misdirected, or carried out in bad faith.

Giddens sees modernity as a juggernaut, 'a runaway engine of enormous power which, collectively as human beings, we an drive to some extent, but which also threatens to rush out of our control . The ride, in an age of high speed travel, electronic formation and globalisation can be exhilarating but, at the same time, lead to feelings of profound anxiety. Giddens argues that, 'rather than entering a period of postmodernity, we are moving into one in which the consequences of modernity are becoming more radicalised and universalised than before'. The reflexivity of modernity is unsettling because it subverts the idea that we can gain certain knowledge and presumes , wholesale reflexivity', including the reflection upon reflection itself:

Modernity turns out to be enigmatic at its core, and there seems no way in which this enigma can be "overcome". We are left with questions where once there appeared to be answers ... A general awareness of the phenomenon filters into anxieties which press in on everyone.

The concept of 'critical modernity', which Giddens also refers to as 'utopian realism', can lead to individual and collective acts to bring about change. The institutional dimensions of modernity, the global abstract systems that seem like an uncontrolled juggernaut, can be guided by human agency. The site of struggle, in each case, may be seen in terms of human communication. Although Giddens holds that Habermas's theory of communication leaves open how this may work in practice, Giddens' own work indicates the importance of dialogue in controlling the juggernaut of modernity. Late modernity, far from being a time of fragmentation of human experience, 'produces a situation in which humankind in some respects becomes a "we", facing problems and opportunities where there are no "others"'. Indeed, in a later work, Giddens agrees with Rorty that a post-traditional order opens the possibility of "a cosmopolitan conversation of humankind", and identifies only four ways in which value disputes can be resolved: embedding of tradition, which in modernity is undermined; disengagement, the possibilities of which are limited; discourse-, or violence.

Language, reason and reality

A vaunted feature of postmodernity is the turn to language—in which language is seen as a productive force that enacts power and does not simply represent the world. This idea, however, is not new and is a feature of the work of linguistic philosophers such as the 'later' Wittgenstein, Austin and Ryle; and of hermeneutics in the work of Gadamer, Apel, and Habermas. Also within anthropology the Sapir-Wharf hypothesis took language as fundamental: 'The "(real world)" is to a large extent unconsciously built upon the language habits of the group', an idea taken up by Winch in *The Idea of a Social Science*, where he writes that 'our idea of what belongs to the realm of reality is given for us in the

language that we use' The relativism that this view of language gives rise to leads, in the work of Lyotard, to a challenge to all universalising 'grand narratives, and their replacement by 'little narratives'; ultimately to a solipsistic and angst-filled loneliness in which each individual is trapped behind their frontal lobes, aught up in texts that constitute their world. This radical relativism, however, has been challenged from different directions. From anthropology, for example, the Sapir-Wharf hypothesis has been undermined. Lukes reports that 'the upshot of language-cognition research is not favourable to the Sapir-Wharf hypothesis. It has been observed that "the fascinating irony of this research is that it began in a spirit of strong relativism and linguistic determinism and has now come to a position of cultural universalism and linguistic insignificance"' .

Horton, in studying the thought systems associated with peoples of sub-Saharan Africa and Western Europe, finds a 'common core' of rationality, central to which 'is the use of theory in the explanation, prediction and control of events. Central too is the use of analogical, deductive and inductive inference in the development and application of theory' . It seems, then, that there is more that unites human beings than divides them, and yet it is division that is constantly emphasised by the discourses of postmodernity.

Habermas holds that the 'furious labour of deconstruction' only succeeds when the paradigm of self consciousness is replaced by the paradigm of mutual understanding. In other words, 'postmodernist' writers, paradoxically, find themselves hopelessly enmeshed in the Enlightenment thinking that they set out to subvert:

Heidegger and Foucault want to initiate a special discourse that claims to operate outside the horizon of reason without being utterly irrational. Those who would

like to leave all paradigms behind along with the paradigm of consciousness, and go forth into the clearing of postmodernity, will just not be able to free themselves from the concepts of subject-centred reason

Habermas is critical of the Enlightenment tradition with its dangerous temptations to essentialise all humanity into a one-dimensional totality shorn of real differences. Yet, this position is a radical *modernism* because it seeks critically to discover the liberating potential in modern culture.

Habermas held that the critique of the western emphasis on logos, from Nietzsche to the postmodernists, gives rise to a quality of expected indeterminacy' that in exposing subject centred reason as 'hollow within and aggressive without' gives rise to nothing more than reason's 'other'. He draws upon the work of the Bohme brothers to identify this as, 'Nature, the human body, fantasy, desire, the feelings'. Thus interpreted, postmodernity is a new Romanticism—a distortion of the human towards the senses, as a counterweight to the Enlightenment distortion towards subjective rationality.

It may be the case that a more balanced human understanding is necessary, not least in education theory, policy and practice, that includes what Taylor referred to as theoretical, symbolic and expressive understanding; or what Habermas refers to as cognitive instrumental, moral-practical and aesthetic-expressive domains of human reason. Such a balance is not achieved by a swing from the hubristic idea that everything can be known, to the weakness of individual language games and parology.

Habermas agrees with those who hold that the paradigm of the philosophy of consciousness is exhausted, however, instead of retreating into postmodern relativism, he returned to the Enlightenment

tradition of western philosophy to uncover a road not taken, and advocates a 'transition to the paradigm of mutual understanding.'

There is no privileged understanding for an individual consciousness (white, male, western, or any other) but: Fundamental to the paradigm of mutual understanding is, rather, the performative attitude of participants in interaction, who coordinate their plans for action by coming to an understanding about something in the world.

As expressed by Thomas McCarthy, 'the challenge then, is to rethink the idea of reason in line with our essential frailty—that is, with the historical, social, embodied, practical, desirous, assertive nature of the knowing and acting subject—and to recast accordingly our received humanistic ideals'

If situated reason is viewed as social interaction, the potential of reason has to be realised in the communicative practice of ordinary, everyday life ... there is an internal relation of communicative practice to reason, for language use is oriented to validity claims ... This orientation of communicative action to validity claims admitting of argument and counter argument is precisely what makes possible the learning processes that lead to transformations of our world views ... the defects of the Enlightenment can only be made good by further enlightenment.

While Habermas realises that this may be interpreted as idealism, he,, argues that, 'there is no pure reason that might don linguistic clothing only in the second place. Reason is by its very nature incarnated in contexts of communicative action and in structures of the lifeworld'. He holds that we took a wrong turn in the road of Enlightenment, asking 'How can I know that something is true?' rather than 'How can members of a

community come to an agreement that something is true?'

Habermas believes that a revival of the public sphere of democratic decision making requires 'the organisation of social communication in a way approximating to an unconstrained dialogue' and 'the development of norms which' could fulfil the dialectic of moral relationships in an interaction free of domination' and the idea of rational, informed discussion is a thread through Habermas's work. With an increase in prosperity 'the interest in the emancipation of society can no longer be articulated in economic terms', or at least, not in those terms alone, but, 'involves the mutual recognition of socialised human beings' (ibid), achieved through communicative action.

In his inaugural lecture as Professor of Philosophy at Frankfurt, in a much quoted passage, Habermas expressed it thus: The human interest in autonomy and responsibility is not mere fancy ... what raises us out of nature is the only thing whose nature we can know: language. Through its structure, autonomy and responsibility are posited for us. Our first sentence expresses unequivocally the intention of universal and unconstrained consensus.

This view of reason and language is important to the healthy foundation of education. The possibility of interaction free from domination, rather than the fragmenting games of postmodernity, should be the touchstone of educational practice. For Habermas, such "ideal speech situations" give rise to a rationally founded consensus, based on a functional view of everyday language use, that what we say is comprehensible, true, right and sincere. This view of the internal organisation of language use coincides with that of philosophers of language, such as Grice, who holds that the fundamental

basis for language is human cooperation, a view sustained more recently by Aitchison. These views are in contrast to the popular, but mistaken belief that the function of language is primarily as a conduit for information—a belief countered by Reddy, but that is still prevalent, even in education.

Habermas argues that factors in the internal organisation of language vie with factors of external organisation, such as who determines the ordering of the discussion, who can participate, in what way—in other words factors of power, that help to shape interaction. He holds that distortions in the external organisation of language lead to systematic distortions in the internal organisation of language. The result is pseudo-communication in which certain topics are avoided, or are presented in untrue ways. The possibility of a truthful and sincere dialogue, leading to consensus, is made unlikely. Although Habermas never intended the ideal speech situation to be understood as a concrete utopia which would, in Outhwaite's expression, 'turn the world into a gigantic seminar' he did distinguish 'the genuinely communicative use of language to attain common goals'—which is arguably the purpose of language use in education—'from strategic or success-oriented speech, parasitic on the former, which simulates a communicative orientation in order to achieve an ulterior purpose'.

Communicative action and education

The influence of Habermas upon educational professionals is not uncontested. For instance, Carr believes that 'the aims and values of a critical social science, as defined by Habermas, are ... virtually identical to the aims and values of education as defined by Richard Peters'. He also sees Habermas's work as providing a foundation for an educational science free

from modern empiricist philosophy. By contrast, Elliott views Habermas's work giving rise to 'a dangerous account of action research' which denies 'the possibility that teachers' self-understandings of their practices can alone constitute a source of critical self-reflection and emancipatory action'.

Habermas's theory of communicative action is still being developed. Taylor believes that it is weakened by a reliance on a Kantian, formal procedural conception of reason which needs to be supplemented by an Aristotelian substantial ethics; that is to say, an articulation of what a community considers the 'good life'. Where education is concerned, it is necessary to hold to the possibility of an unconstrained dialogue about its purposes and how they relate to the wider good.

To give efficacy to Habermas's concept of communicative action, and to Carr's call for a science for education, it is necessary to make classrooms, especially for those over 16 in further and higher education, more open in patterns of communication. It has long been known that in many classrooms learners are relatively passive recipients of teaching, even when they are organised in groups. Young pointed out that in much educational practice students 'are seen as individuals who must simply be made to reproduce the point of view being advanced, by whatever means seem expedient and economical. This is already well on the way to treating students like things'.

The work of the constructivist psychologists, such as Bruner, Vygotsky and, more recently, Gardner points to the importance of the active engagement of the student in effective learning. Learning is 'a complex interweaving of language, interaction and cognition'. The implementation of key skills in communication, working with others and

problem solving, as almost universally advocated by learners, teachers and employers, and soon to be implemented for most learners post-16 creates an expectation that students will be given opportunities to speak, listen and respond, as an integral part of their learning. Many teachers, however, may sense that more interactive classrooms are desirable and possible, but fear that they lack the knowledge and skills to achieve this.

The advantages of people learning in more communicative ways, in which dialogue is less constrained and interaction free from domination, have long been recognised for example, an OECD report of 1978 stated that:

A large number [of Secondary pupils] in all countries lack motivation in school and later fail or underachieve badly ... What is now required is a radical rethinking of this phase of education, taking the adolescent pupils and their views as the point of departure. This will involve widespread changes in curriculum, in personal relations, in assessment, and in guidance and orientation.

Communication styles research to shown the great importance of affectivity in classroom interaction i the perceptions of learners, even on highly instrumental vocational courses such as engineering. What students seek in a teacher is skilled communicator who combines warmth and understanding with efficient management of learning and high standards Learning in post-16 education is not a matter of mere transmission of information, in which language is a conduit, but involves the whole person in dialogue, rather than monologue. Young adult seek respect or 'face', one characteristic of which is being allowed some autonomy in the learning process, which in turn require more open patterns of language use by learners.

The advantages of developing warmer, more interactive relationships between teachers and students are numerous and include: more effective academic learning; the promotion of healthy social and emotional growth; and the overcoming of social disadvantage. It is not necessary for teachers to become friends, confidants, social workers or counsellors for mutually respectful and warm relationships to become established.

According to Deiro, primary strategies used by teachers to bond with students, within the context of an asymmetrical professional relationship in which the teacher is a change agent, empowered over the learner, are: one-to-one time; self-disclosure; and having high expectations, while conveying a belief in students' capabilities. Teachers who succeed in this are, for example, willing and able to converse with students outside the formal context of classroom and subject; and to give personal information that is pertinent to context and content and that helps students to relate learning to human experience.

Oakeshott, who advocated that education be a conversation that is tolerant of different voices, quoted an Eton master, 'you go to a great school not so much for knowledge as for arts and habits ... entering quickly into another person's thoughts ... submitting to censure and refutation ... indicating assent or dissent in graduated terms'. More recently, Rodenburg compared the use of language in a comprehensive school to that at Eton: whereas in the latter students discussed freely in class, in the comprehensive a silence prevailed that amounted almost to verbal deprivation. Young people, more than ever before, can obtain knowledge from IT sources and libraries. What they need are educational settings in which they can interact with teachers and with one another to learn the human significance of this knowledge and, at the same time, to learn about

themselves and about difference and tolerance. Education requires more than a Kantian treating of persons as ends in themselves. It requires as well the affirmation of the person as a person, in a process which balances personal and rational autonomy with the fact that the everyday life of humans is one of coexistence.

In the process of education, language use ought fundamentally to be about cooperation rather than antagonism, solidarity, not difference. This is not to deny difference, or to bury it in a spurious unity, but to recognise that there is more that unites human beings than divides us. It is this central feature of the educational endeavour that should be protected from the radical relativism of postmodern claims.

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